DOCUMENT RESUME

ED 468 653 CE 083 832

AUTHOR	Carlton, Shiela
TITLE	Life, the Universe and Almost Everything: The Value of Adults Learning in Science. A Policy Discussion Paper.
INSTITUTION	National Inst. of Adult Continuing Education, Leicester (England).
ISBN	ISBN-1-86201-127-3
PUB DATE	2001-00-00
NOTE	72p.
AVAILABLE FROM	National Institute of Adult Continuing Education, 21 De Montfort Street, Leicester LE11 7GE, United Kingdom. Web site: http://www.niace.org.uk.
PUB TYPE	Books (010) -- Opinion Papers (120)
EDRS PRICE	EDRS Price MF01 Plus Postage. PC Not Available from EDRS
DESCRIPTORS	Access to Education; *Adult Learning; Adult Students; Change Strategies; Colleges; *Educational Benefits; *Educational Change; Educational Needs; Educational Opportunities; Educational Policy; Educational Trends; Equal Education; Foreign Countries; *Lifelong Learning; Literature Reviews; Mass Media Role; Needs Assessment; Policy Formation; Position Papers; Postsecondary Education; Relevance (Education); Science Instruction; Science Teachers; *Scientific Literacy; Teacher Attitudes; Technological Advancement; Technological Literacy; *Technology Education; Universities
IDENTIFIERS	Educational Marketing; Learning Society; *United Kingdom

ABSTRACT

This paper explores the value of encouraging adults in the United Kingdom to participate in learning in science through extensive consultations with practitioners in the field of science education. Data were also collected through a literature review and a brief survey to collect views regarding adults' participation in learning opportunities in science. This paper reports that the analysis confirmed the need to promote and develop additional opportunities for adult participation in education in the sciences, engineering, and technology. The following were among the nine broad suggestions for promoting more democratic access to dialogue and debate about science matters and to widen participation in related learning: (1) initiate planning for a more coherent and flexible lifelong learning curriculum responsive to communities and interest groups; (2) celebrate and promote examples of good practice encouraging adults to learn more about science for its own sake; (3) develop wider access to initial and in-service training provision in relation to science teaching; and (4) expand access to short courses in media presentation and communication for scientists and journalists. Thirty-eight specified recommendations directed toward specific agencies were also presented. The following items are appended: lists of core members of the Advisory Group on Adult Learners and Science and survey respondents; selected statistics; and a 53-item bibliography. (MN)

Reproductions supplied by EDRS are the best that can be made
from the original document.

ED 468 653

Life, the Universe and Almost Everything

The Value of Adults Learning in Science

A Policy Discussion Paper

PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL IN MICROFICHE AND IN ELECTRONIC MEDIA FOR ERIC COLLECTION SUBSCRIBERS ONLY, HAS BEEN GRANTED BY

P. Moledina

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

2A

Shiela Carlton

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

☒ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

NIACE

CE083832

BEST COPY AVAILABLE

2

Life, the Universe and Almost Everything

The Value of Adults Learning in Science

A Policy Discussion Paper

Shiela Carlton

NIACE
THE NATIONAL ORGANISATION FOR ADULT LEARNING

Published by the National Institute of Adult Continuing Education
(England and Wales)

21 De Montfort Street
Leicester
LE1 7GE

Company registration no. 2603322
Charity registration no. 1002775

First published 2001

© 2001 National Institute of Adult Continuing Education
(England and Wales)

All rights reserved. No reproduction, copy or transmission of this publication may be made without the written permission of the publishers, save in accordance with the provisions of the Copyright, Designs and Patents Act 1988, or under the terms of any license permitting copying issue by the Copyright Licensing Agency.

NIACE
THE NATIONAL ORGANISATION FOR ADULT LEARNING

NIACE, the national organisation for adult learning, has a broad remit to advance the interests or adult learners. It works with national and local government, education providers, TECs, employers, the voluntary sector and others to promote equal opportunities of access to learning for all adults.

Cataloguing in Publication Data
A CIP record of this title is available from the British Library

ISBN 1 86201 127 3

Design and Typeset by J&L Composition Ltd, Filey, North Yorkshire
Printed and bound by Alden Press, UK

CONTENTS

Preface	v
Foreword	vi
Summary	1
Creative sparks	3
Science for all	6
Lifelong Learning Society	16
What about the learners?	20
Providers and programes	33
Promotion and publicity	49
Things can only get better	54
Appendices	58

PREFACE

This paper squares up to the central issue shaping the type of people we will be and the type of lives we will live in the twenty-first century. This is a century where the democratisation of knowledge, lifelong learning and the impact of science on everyday life necessitate a serious examination of how to equip the everyday citizen to contribute to the good of the community to the full.

Although the print and broadcast media, as well as an increasing number of authors, can disseminate facts, facts on their own are insufficient. First the facts need to be related by the individual to their own reference base, so that they might develop ideas. As a consequence and most importantly, once empowered they must be allowed to enter into open debate. This scenario is no more appropriate than for science.

Traditionally science is not within our culture and is left to a minority of 'nerds'. The concept of scientific literacy is surely one to develop, whereby even those not aspiring to degrees in science nonetheless understand enough of the basic concepts to participate in the debate. There is no reason why, in the future, the public should not go to science-based events, lectures and discussions, for the same excitement and enjoyment as they currently do to the opera, ballet, cinema or concert.

Only once the individual understands the basic concepts in the whole spectrum of science, and most importantly of all, how science is actually conducted, will they be able to access an appropriate context for understanding the various issues that arise. For example, if everyone knew of the reason for 'peer review', the needs for controlled experiment and the iterative process by which scientific findings are established and accepted, then the furore over genetically modified (GM) potatoes giving rise to the GM foods debate would have been more openly and fully evaluated.

Moreover sensationalist phrases such as 'Frankenstein's food' would have no purchase in a society where people could understand the very term to be absurd. Scientific literacy in particular would also equip individuals with an appropriate mindset for evaluating the issues of In-Vitro Fertilisation (IVF), designer babies and virtual babies, without the knee-jerk hysteria and prejudice that seems to accompany such developments.

Up until now the problem has been that although the sentiments for democratisation of science and continuing lifelong learning have been laudably expressed we do need hard policies and means for their implementation. I welcome this Paper as a first step towards that goal.

Baroness Susan Greenfield, CBE

FOREWORD

Many years ago C.P. Snow argued that there had developed in Britain an unhealthy dichotomy between the 'two cultures' of science and the humanities. Whatever the rights and wrongs of that particular formulation, two factors at least seem to be beyond dispute: the division and mutual misunderstandings have grown in recent years between those with a humanities perspective and those with a scientific or technological orientation; and the importance and impact of science and technology in the modern world have increased enormously. None of us, like it or not, remains unaffected by science and technology. Everyone must now be aware at a general level of the fundamental developments taking place and their possible benefits and dangers.

Adult learning has a key role in this context. This Paper provides vision, enthusiasm and most important of all practical examples of innovative good practice in science and technology education. It provides a good basis to carry forward the argument – to government, to educational institutions and to the media – that in the twenty-first century raising the level of knowledge and understanding of the scientific and technological revolution is not a luxury, it is a necessity. This is, in part, because of its crucial and increasing importance in skills training and labour market terms, but equally, a general understanding of science and technology is essential for an informed and vibrant democracy.

The Paper is a rich resource and a stimulus for further debate and development. Our thanks are due to Shiela Carlton and her colleagues for an impressive and valuable piece of work.

Professor Richard Taylor
Chair, NIACE Executive Committee

SUMMARY

NIACE is committed to the promotion and development of wider participation by adults in all forms of learning, with opportunities throughout their lives to learn for interest and personal development as well as social and economic change. In publishing this policy discussion paper, NIACE addresses particularly the role of adult education in fostering wider public knowledge, understanding and critical interest in science and technology, for everyone. In doing so, it concentrates on the need for:

- knowledge about current topics, empowering people to understand the questions to ask and critically weigh the answers;
- the democratisation of knowledge, in order to foster critical thought and confidence in addressing developmental issues;
- active citizenship, in positive engagement with policy and practice in scientific and technological matters;
- social inclusion, in relation to those who are currently marginalized or excluded from the science debate, whether culturally or otherwise;
- lifelong learning opportunities, through different pathways, in order to pursue personal passions and develop a more interesting quality of life, for all;
- better means of promoting the relevance and value of learning in the sciences;
- explicit policies, planning and resources to develop wider participation in all forms of learning about science.

In preparing this paper NIACE has consulted widely in the field of science education, including a brief questionnaire distributed and analysed in the autumn of 2000, and has drawn on many different experiences and expertise. While citing examples of good practice, the paper is not based on an audit of provision or any comparisons of outcomes, but aims more to encourage policy makers and practitioners concerned with broad adult education (including Further Education (FE) and Higher Education (HE), and work-related learning) to commit themselves to widening participation in learning about science and technology in particular.

In this Year of Science, the paper is intended to emphasise the need for adult learners' better access to learning programmes and experiences as a pre-requisite to engaging with the public's interests and concerns about science and technology. It contributes to the national agenda for developing more and better lifelong learning opportunities for everyone, for all aspects of personal and skills development, and community regeneration. It offers examples of good practice and makes recommendations in order to elicit a response from organisations providing all forms of education for adults, and their teachers and learners as well as a range of different audiences including Government (national and local), professional institutions and funding agencies, broadcasters and the media, and all concerned with the promotion of education in the sciences, engineering and technology.

To promote more democratic access to dialogue and debate about science matters and to widen participation in related learning, the following broad suggestions are made:

- to initiate planning for a more coherent and flexible lifelong learning curriculum, responsive to communities and interest groups;
- to develop better national targets for lifelong learning generally, in order to encourage wider participation in science-based learning;
- to celebrate and promote examples of good practice which encourage adults to learn more about science for its own sake;
- to develop partnerships in science education provision, connecting informal, non-formal and formal learning programmes in different modes to provide pathways for learners' choice of progression;
- to develop wider access to both initial and in-service training provision in relation to science teaching;
- to expand access to short-courses in media presentation and communication for both scientists and journalists;
- through appropriate delivery points, to provide better information, advice and guidance about science subjects, for potential new learners;
- to develop a stronger resource base for science teaching and learning, through funding channels to support a broader range of provision and to fund more learners directly;
- supporting the work of the British Association for the Advancement of Science (BA), the Royal Institution and other interested organisations, to institute a concerted campaign on a wider front, initiated by the Department for Education and Skills with other Government Departments to follow the current Year of Science.

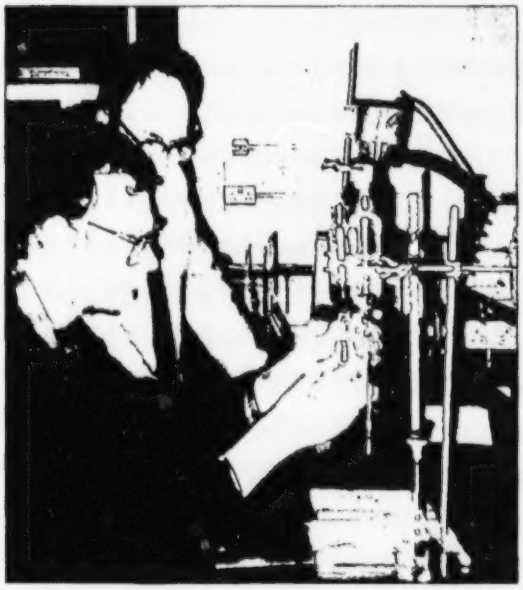
At the end of the paper, these recommendations are set out in more detail for specific agencies, under the optimistic heading 'Things can only get better'.

NIACE welcomes the opportunity to contribute to the debate about adults' access to science knowledge and the need for wider participation in related learning. If you wish to comment or discuss these issues further, please contact Shiela Carlton via the NIACE main office in Leicester.

For more than 500 years, Britain's scientists, both amateur and professional, have been at the forefront of technological developments. In a small country with limited natural resources, researchers and entrepreneurs have primed innovation and invention, prepared to experiment and take risks in the process of acquiring new knowledge. Technological developments have steered social and economic development, with especially rapid change over the last 100 years. New discoveries and applications have improved the quality of our lives, at home as well as at work, in industrial laboratories as well as pure research environments, on the shop-floor as much as in the boardroom. New science knowledge has been pursued as much through personal curiosity and satisfaction in finding out, as by means of academic qualification routes.

This has not been an entirely beneficial process however, and every step forward has been accompanied by new problems and ethical dilemmas. One important debate is about the need to share knowledge with a wider public and to develop a better understanding of the uncertainties and collective decisions associated with scientific processes. The key to progress relies on opening up a broad range of learning opportunities in different educational settings to enquiring minds of all ages and stages of knowledge. For some time, however, the purpose of science education has been defined more narrowly as the provision of structured, specialist training in order to contribute to the regeneration of the economy, rather than to be broadly educational.

Greater participation in initial school education provision over the last 150 years has produced a more articulate and questioning population, but conversely, over the last 25 years or so, the emphasis on vocational education for labour market skills has narrowed the range of adult learning opportunities and reduced public engagement with learning new things primarily for interest and enjoyment. The concentration of resources on equipping young people with formal qualifications for entry to employment has excluded a large proportion of the adult population over the age of 25, and inadvertently reduced the potential pool of skills and experience available to the community for wider purposes.



Despite a clear appreciation of better means of food supply, communications, travel, industrial and domestic environments, even if not yet enjoyed by all, there is public suspicion of the motives of government, institutional and commercial interests in promoting and applying new technological developments. Additionally, pure science subjects are perceived to be abstract and difficult to understand. As a consequence, younger people are less attracted to studying science subjects beyond the statutory

requirements of the school curriculum, older people are anxious about their knowledge being out-of-date and their experience being undervalued, women and girls still feel unwelcome in male-dominated technical environments, and the culture of science sits uneasily with other cultural mores and disciplines.

The public generally is not offered clear information underpinned by contextual knowledge, on which to base judgements about science-based issues. Anxieties about nuclear power or climate change, the crisis about the origins and effects of Foot and Mouth and BSE viruses, the reaction against genetically modified crops and possible contamination of foods, all demonstrate both public suspicion and the damaging effects of inadequately informed public debate. Such issues also demonstrate the real uncertainties in obtaining and interpreting reliable data. These are compelling reasons to develop better learning opportunities and more open structures to ensure that such debates have a wider hearing from the outset, with the chance of achieving a more effective consensus for action.

In Science Week in March 2001, Stephen Byers as Secretary of State at the Department of Trade and Industry (DTI), in a speech entitled *Science people can trust*, said to a meeting of the British Association for the Advancement of Science (BA), 'Science is too important to be left to the scientists'. He emphasised the need to ensure people's access to science knowledge and debate in order to develop public confidence and identified an essential part of the remit of the Government's Scientific Advisory Committees, within a new Code of Practice, to be transparent and accountable in communicating with the public. As an educative process however, he saw schools and young people aged 10–19 as the most important focus for conversion, thus anticipating a lengthy time-scale. The Minister's speech built on the *Science and innovation* White Paper launched in July 2000, outlining the Government's proposals for fostering a confident public relationship with science while investing more resources in the UK's research base, particularly for universities to support the commercial applications of research through the Higher Education Innovation Fund.

In 1993, the Government produced a White Paper *Realising our potential* that said at the beginning,

> 'The understanding and application of science are fundamental to the fortunes of modern nations. Science, technology and engineering are intimately linked with progress across the whole range of human endeavour, educational, intellectual, medical, environmental, social, economic and cultural...Science and engineering also make a most important contribution to improved public services and the quality of life.'

Concerned, however, about people's wariness of science and technology, the Government continues to support initiatives which promote better public understanding, so that the DTI's Office of Science and Technology now provides about £4.5m per year for this purpose. In this context, it is important to remember that for social welfare, wealth creation is not only an economic goal but includes the spiritual also: the development of a cohesive and inclusive society, with agreed values and communal knowledge; extending thinking; and reflection for social and personal development. Both the sciences and the arts share a common goal of understanding and dealing with the human condition and equally cultivate essential skills of analysis, expression and communication.

For some time now, it has been recognised that widespread lack of engagement with science knowledge is a problem, whether measured by labour-market shortages of specialist skills

for industry, commerce, research and teaching, by lack of public support for investment in research and development, by a deficit of literacy and numeracy, by a lack of trust in scientific and technological developments, or by limited appreciation of the creative excitement of science awareness. The knowledge base of society – and that means all of us – needs to change rapidly in order to match the rate of development of science and technology, and optimise its use with equity for all. More than ever before it is unrealistic to suppose that initial education, whether to age 16, 18 or 21, can equip us adequately for the rest of our lives. The pace of change is now too fast for knowledge to be handed down from one generation to another in the old-fashioned way. At the same time, we can neither wait for the young to grow their own expertise nor afford to waste the enthusiasm and experience of our older population. We need a science-knowledgeable population now and that means providing access to knowledge for both older and younger people throughout their lives, in a variety of ways, flexible and responsive to different needs at different times.

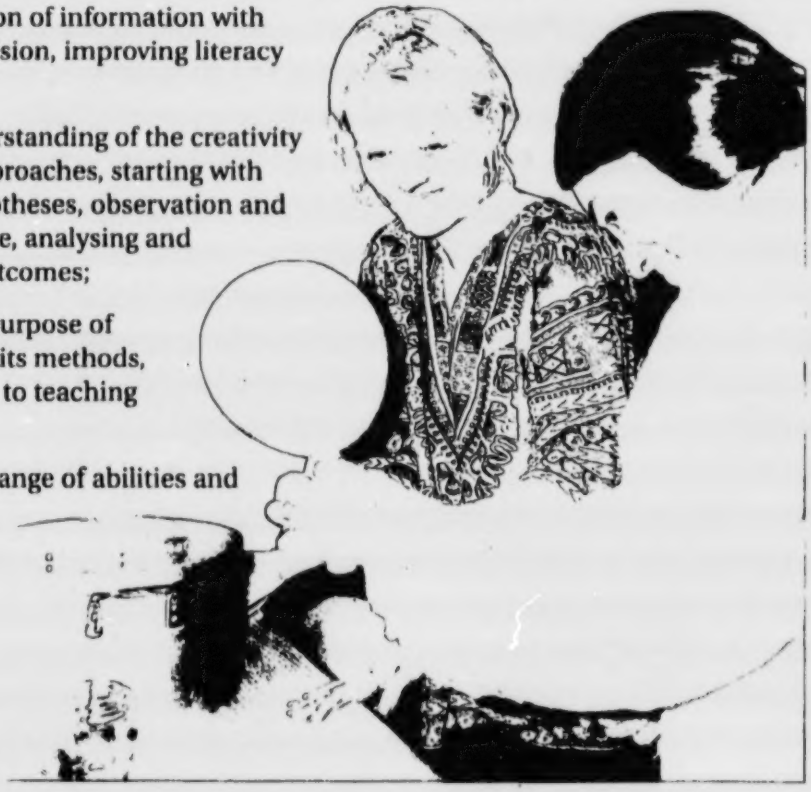
In the White Paper *Learning to succeed, a new framework for post-16 learning* published in June 1999, The Secretary of State for Education and Employment said,

> 'Lifelong learning can enable people to play a full part in developing their talent, the potential of their family, and the capacity of the community in which they live and work...This will ensure the means by which our economy can make a successful transition from the industries and services of the past, to the knowledge and information economy of the future. It also contributes to sustaining a civilised and cohesive society, in which people develop as active citizens and in which generational disadvantage can be overcome...We must place the learner at the heart of the new system.'.

Significantly, the original meaning of science was simply knowledge, in the sense of all-encompassing, and the original academic term for physics, for example, was natural philosophy, reflecting a more comprehensive and environmental view of the subject than is conveyed by its current title. Taking this more worldly view, everyone needs to know some science. Knowledge of science and technical skills can contribute to the common good and are important to the development of more sustainable communities, particularly when exercised with confidence and commitment.

Access to education in the sciences is a useful paradigm for adults' entitlement to equity of learning opportunities overall. Scientists and science educators therefore need to reach people in ways which engage their interest and enthusiasm, including non-scientists. This is not only for the self-evident reason that everyone needs the best understanding of the environment they live in and how it works, in order to be active citizens of the world, but also for a wider variety of other purposes including:

- ☐ for personal development, following up their own interests in their own time, often just for fun;
- ☐ to encourage people to be curious and questioning, to enjoy discovery and learning new things;
- ☐ to develop critical and abstract thought processes, analysing data and information, assessing risks, connecting theory and reality, putting ideas in context;
- ☐ to develop expression of information with definition and precision, improving literacy and numeracy;
- ☐ to develop an understanding of the creativity of experimental approaches, starting with ideas, forming hypotheses, observation and assembling evidence, analysing and reflecting on the outcomes;
- ☐ to understand the purpose of advanced research, its methods, outcomes and links to teaching and learning;
- ☐ to canvass a wider range of abilities and develop skills for work at all levels, not only for graduates and post-graduates in research programmes, but also for



6

technicians, teachers and science or technology-based workers in all sorts of industrial, commercial, public service and domestic environments;

- ☐ to develop a sense of public ownership of and support for publicly-funded research in a variety of settings;
- ☐ to avoid the potential divide into the knowledge-rich who understand science and the knowledge-poor who are not included in that understanding, both in life and as abstract ideas.

Science Shops were first set up in Dutch universities in the 1960s and are now an established part of many universities all over Europe. They provide access to university staff and student resources and research for community and voluntary groups which lack money but need to find detailed knowledge. The Northern Ireland Science Shop was established in 1989 with sponsorship from the Nuffield Foundation, and has offices at Queen's University Belfast and the University of Ulster in Londonderry. Requests for assistance are accepted on a wide range of subjects including environmental and community health issues. Examples are: biology and chemistry students helping to analyse the contents of open drains suspected of being a health hazard; assistance with updating the Environmental Strategy for Northern Ireland; assistance with creating a waste management strategy; research on the geography, geology and natural science habitats of Upper Lough Erne. In the ten years from receiving their first request for help in early 1989, the Northern Ireland Science Shop has dealt with more than 700 queries or projects. There is a website, with a news bulletin and archive list, and in 1999, a major tenth anniversary conference was held at Queens University.

Science knowledge can operate at different levels and most people do not need to become a specialist or an expert, but they do need sufficient knowledge to sustain independence of thinking and living. The perception of the public as seemingly passive and powerless consumers of technology needs to be changed towards a view of them as active and critical participants in debates about how society uses science and comes to decisions about it for individual and community purposes in everyday life. For example, some guidelines towards such entitlement might relate to a sufficient level of knowledge to:

- ☐ be sufficiently numerate to account for personal resources and to interpret common data;
- ☐ assess the costs and benefits of different energy sources;
- ☐ compare the properties of materials useful for different purposes;
- ☐ assess the environmental impact of agricultural, horticultural and animal husbandry, and changes made to the landscape;
- ☐ understand the chemistry and biochemistry of foods and preparation techniques;
- ☐ be curious about our own genetic make-up;

- understand our own health, with the chemical and physiological effects of medication;
- be visionary about the future for travel and communications;
- contribute knowledge and research skills to collective projects for community empowerment and development.

Of course, some science (such as quantum mechanics) is only accessible to the specialist. Equally, the public includes scientists *outside* their own specialism and, therefore, not necessarily better informed about other topics. Overall, learning in and about science is essentially about ways of thinking and understanding so that it is more important to ensure that people have sufficient access to knowledge and information, to be aware of the boundaries of their own competence and to know where they can go to learn more or find specialist help. While there is inevitably a limit to the depth of understanding that can be achieved by a generalist approach, it can provide a better awareness of the main issues, as well as a foundation for further study if required.

It is evident that the public continues to be interested in science-based knowledge, demonstrated by participation in other informal ways, such as:

- around 1.2m visitors to the Science Museum and 1.75m to the Natural History Museum per year;
- weekly television audiences reaching as much as 7m for BBC's *Tomorrow's world*, over 3m for *Horizon* and *The natural world* and 0.25m for radio's *Materials world; Walking with dinosaurs* was the seventh most watched television programme of 1999, with an audience peak of 15m;
- up to 3m viewers for Channel 4's *Equinox*, supported by the addition of Science Line for freephone information;
- the popularity of the Royal Institution's science lectures on television at Christmas, with an average of 0.5m viewers per episode;
- 500,000 readership of *New scientist* weekly, covering a wide range of both amateur and professional interests, across an age range of 7–94;

- the huge range of current book titles on popular science themes and record book sales of 500,000 in the UK alone, of Stephen Hawking's *A brief history of time* (even if most of us never got beyond chapter 3);
- public libraries across the UK, where there were about 4.6 million loans of science and technology non-fiction to adults in 1998/99, with the same amount again for nature and country life, and even more in health subjects.

The Natural History Museum in London has always captured the public imagination, through its collection and presentation of biological and geological materials. The interactivity of the Earth Galleries, taking participants through a demonstration of the origins of our planet, is backed up by the Earth Lab, where technical facilities, advice and reference sources are available to users wishing to follow-up their own line of enquiry or identify their own rock, fossil and mineral specimens.

The Museum supports a team of dedicated staff for education provision and holds adult education courses and events, open to all adults and accessible at three different levels: for those with no subject experience, for those with some experience or who have studied their choice of subject in the past, and for those with expertise but wishing to take it further. There are no examinations or formal assignments. There are workshops, walks, field study tours in the UK and abroad, as well as summertime and day schools in Earth Sciences and geology, Life Science (including field illustration) and Botany (both historical and ecological). Subjects are thematically linked to the Museum's exhibitions and there is also a special lecture series open to the public. There is a strong focus on family groups learning together. Tutors are drawn from the Museum's staff or from the University of London's Birkbeck College, where the Centre for Extra-Mural Studies provides programmes of broad, liberal adult education.

Under the headline *Sharing our Skills* the Museum offers short courses (one- or two-day) for other museums' staff on such diverse topics as Web Design, Education from Policy to Practice, Access (and tackling social exclusion), Positive Programming (to target new users), Interpretative Materials, Producing

Interestingly, public knowledge and understanding of weather and climate have increased tremendously with improved meteorological measurement and its televisual broadcasting, as a spin-off from journeys into space, while widespread interest in environmental issues connects with closer views of wildlife and habitats. In these instances, people have identified their own interest and chosen a level of knowledge to suit their own purposes. Through their own hands-on fieldwork, observation and experimentation, they have experienced the fascination and excitement of scientific discovery, as well as the uncertainty of outcomes.

But science knowledge is neither neutral nor absolute. All types of specialist knowledge bear a dimension of power, enhancing the influence of those who have it and excluding those who do not. The debate about ownership of this power was evident in the progress of the human genome project when there was concern that research outcomes could be patented and exploited commercially as the private property of vested interests, while an opposing view defended the concept of public ownership for the public good. Democratically, the exclusion of the public from the means of directing their own lives must be challenged, as scientific and technological developments have huge and direct effects. The public tensions and anxieties around fertility, genetic cloning and disease, with medical, surgical or veterinary interventions, point to the need for open, informed and ethical debate, with understanding of the technical issues and uncertainties in order to reach some level of agreement. People need to know what is being done in their name. Conversely, lack of access to knowledge and critical understanding disenfranchises the majority, and inevitably reduces the essential accountability of scientists to the paying public. Overall, there is a historical view of science as a body of highly specialised individuals with absolute knowledge enabling scientists to maintain a level of power, prestige and exclusivity which prevents the rest of us feeling good about it, or confident about asking questions.

In 2000 the Royal Society for the encouragement of Arts, Manufacturers and Commerce (RSA), concerned about the need to ensure and refine mechanisms for public debate on science and technology issues, established a *Science and Society* project to share and air views publicly. This year a *Charter for Science and Engineering* was launched by the Royal Society of Chemistry (RSC) and others to exhort policy and public support for science as essential and integral to the welfare of society. The Charter emphasises the need for equal opportunities for all, to maximise science and engineering potential and to promote a well-informed population. *Article 5: education* concentrates on the need to ensure a supply of well-qualified and supported teachers. At the same time, the Government asked Sir Gareth Roberts, Master of Wolfson College, Oxford, to lead an independent study into the supply of skilled scientists and engineers, to be reported by February 2002.

In 1999/2000, the House of Lords Select Committee on Science and Technology conducted an investigation into public attitudes to science and the need to promote greater confidence and trust, producing a report, *Science and Society*, early in 2000. Within this, the Committee said,

> 'Although scientists are in a minority of the population, democratic citizenship in a modern society depends, among other things, on the ability of citizens to comprehend, criticise and use scientific ideas and claims...Public misunderstanding may lead to technology being rejected, it may also lead to technology being abused...The state of the relationship between science and society is therefore of importance to society and it is also of great importance to the scientific community itself. Scientists are part of society and work in a social context.'.

The report also encompassed much useful information on earlier research surveys of public attitudes, conducted by different organisations. For example, Durant and Bauer, commissioned by the Department of Trade and Industry's (DTI's) Office for Science and Technology together with the Nuffield Foundation, found in 1997 that about 60 per cent of the public indicated an interest in science generally and over 80 per cent were interested in

new scientific discoveries and technological inventions. The RSC in 1985, among other findings, had concluded that:

- most people's perceptions of chemistry derived from school, where it was recalled as boring;
- most primary school teachers saw chemistry as 'a difficult and boring subject, pursued by intelligent but unimaginative people';
- those best informed about chemistry were those with children in secondary school, while the worst informed included a large proportion of teachers, especially primary.

More recently, a study carried out by the National Centre for Initial Teacher Training in Primary Science found that children continue to see scientists as boring eccentrics who have no fun.

The earlier RSC survey also observed that people showed awareness of the difficulty of dealing with uncertainties and risks, but were well able to reach their own sensible conclusions about these issues. Finally, the RSC concluded that local networks could function better than national networks, and that people respond to science in direct relationship to its relevance to their own interests: a highly significant message for those providing any learning programme or activity.

Many of these studies did not take into account possible differences of view relating to age, gender and sexual orientation, religious or cultural background, or socio-economic group. However, in general, they are framed against a background assumption that the problem is mainly one of the public's mis-understanding of science information and scientists' specialisms, and that this can be readily corrected. This interpretation of deficiency avoids facing up to the question of who has the primary responsibility to communicate knowledge and understanding.

Also in 1985, the Royal Society produced a report on *Public Understanding of Science* by a group chaired by Sir Walter Bodmer FRS, saying, 'It is clearly a part of each scientist's professional responsibility to promote the public understanding of science'. This report led, among other things, to the establishment in 1986 of COPUS, the Committee for the Public Understanding of Science, by the partnership of the Royal Society, the Royal Institution and the British Association for the Advancement of Science. Since then, COPUS has worked to promote and communicate the value of science research and education, through networking and sharing best practice, communicating information about new developments and giving grants for innovative projects.

Recently, there has been an increasing acknowledgement that scientists bear at least an equal, if not greater, share of responsibility for improvement of information communication about their work and role. Many specialists experience difficulty in communicating with the public through press and broadcast media, although the failure of non-expert press journalists to investigate in-depth is also a factor in the problem. In early 2001, MORI produced a report *The role of scientists in public debate* based on a survey of practising scientists in various subjects and work settings, and commissioned by the Wellcome Trust with a funding contribution from the Government's Office of Science and Technology.

The British Association for the Advancement of Science (BA) is one of the biggest providers of informal learning by means of events and information. Founded in 1831, the BA is a unique nationwide organisation for individual, family and corporate membership, dedicated to the communication, appreciation and promotion of science, engineering and technology knowledge. Among its main objectives are to provide opportunities for people to participate in scientific activities and their practical uses, and to foster open, informed, public discussion of science issues in their social, economic, environmental and ethical context. It operates through regional branches and does much of its work in conjunction with scientists in the professional associations and in higher education, as well as science-based industry.

The BA organises Science & Public Affairs Forums for open public debate and jointly with the Royal Society, publishes a supporting Science & Public Affairs magazine. It also organises annually National Science Week in March (1.5 million visitors at more than 2,300 events in 2000) and the Festival of Science in September. Last year's festival included a focus on Creating Sparks a celebration of the conjunction of artistic and scientific culture. These national activities attract a great deal of press publicity, as they are usually exciting and imaginative, like the race of boats made from recycled materials down a scale model of the river Tees, or engaging participants with forensic science by setting up a murder with evidence to solve.

In 1986, the BA established the Committee for the Public Understanding of Science (COPUS), jointly with the Royal Society and the Royal Institution. Via Media Fellowships and Workshops, COPUS and the BA aim to encourage and enable scientists to communicate effectively, especially with the public through the Press and broadcast media. COPUS also advises the Royal Society on the Michael Faraday Award, given annually to practising scientists for effective promotion of the public understanding of science.

The BA's recently developed AlphaGalileo internet-based science news service provides easy access to science developments by media journalists. The Visions for the Future initiative brings together young people to discuss what future generations will want from science and technology, with a pilot project Vision On-Line in tandem with the Government's Young Foresight programme. The BA produces a membership newsletter *The Banter* and has published *Science Places*, a handbook of the UK's scientific attractions.

Among key findings, this showed that most scientists appreciate the benefits of a greater understanding of science among the non-specialist public, and nearly all thought that they had a duty to communicate the social and ethical implications of their research to the public. However, lack of public knowledge and education about science was seen to be a barrier to achieving better dialogue, compounded by scientists' lack of available time, funding and training for communication skills.

12

For many people, scientists continue to be seen as mad, bad and dangerous to know – boffins who can function only in laboratories and cannot relate to the everyday concerns of the rest of us. At the same time, scientists feel that their work is not well recognised or rewarded and that their commitment is undervalued by society. The 'well-educated' person is seen to be arts-based, in less applied but seemingly more cultured subjects like history, humanities, languages or the law. Paradoxically, many of the personal skills of reasoning, communication, imagination and expression attributed to practice in arts subjects are equally outcomes of a science-based education, and many art forms function within complex technological parameters, with new materials needing science-based solutions. But the impression that science and technology are closed and confined subjects permeates all age groups, with a 16-year-old saying 'I'm not interested in engineering, it's not creative' and at the other end of the spectrum, an 81-year-old saying 'People taking adult education courses for the pure love of learning, rather than to further their careers, would choose art or literature or history'.

A constant plaint of scientists is that they are well-rounded people, equally involved in music, theatre and painting, whereas those qualified in the arts feel no necessity to understand or be articulate about science subjects. Yet this is a distinct functional change compared to views evolved during the sixteenth to nineteenth centuries, when the well-educated were also concerned to be equally well-versed in their scientific knowledge. By the end of the nineteenth century, workers' entitlement to learn more widely than for work alone was appreciated and supported, and the movement to provide access to broad, liberal adult education was the result. The development of the Mechanics' and Working Men's Institutes, albeit gender-specific, took place alongside a proliferation of public lectures and meetings about science, and a volume of science writing by a diverse authorship. Much of that ethos has been lost in more recent history. Specialisation in single science subjects for vocational ends has eroded this general ownership. While substantial contributions of experimentation and data have always been made by amateur scientists, notably in astronomy, geology, ornithology and environmentally-based subjects, you need qualifications as a physicist, chemist, biologist or other 'expert' to engage in public scientific debate now.

Within the formal education system, however, there are distinct barriers to adults' access to learning. Some apply generally to all subjects of study and are already well-known, such as a lack of suitable programmes in nearby locations, inconvenient timetabling, difficulties with travel and transport, money for fees as well as living expenses, and carrying on the responsibilities of job, home and family care while studying. Fear of failure looms large for adult learners, conscious that their study skills are rusty and that it is a long time since they have had to undergo any form of assessment. This lack of confidence applies particularly in relation to science subjects which are perceived to be abstract and difficult, inevitably requiring an advanced facility in maths, an even more difficult subject.

Much of this disenchantment stems from childhood. Many adults have neither enjoyed science at school nor successfully achieved examination successes, so that they feel they have failed at an early stage. Science subjects are seen to be hierarchical, concentrating on teaching a systematic body of knowledge of structures and techniques, rather than conveying a more holistic view of how the world works and how different aspects inter-relate. Progress in learning seems to be beset by hurdles of examinations, with the ultimate objective of producing trained scientists, rather than interested generalists. Of course, there

is a clear need to ensure an adequate supply of qualified scientists and technologists for professional practice, but this narrower purpose should not result in the exclusion of those who want to learn about science as a broader knowledge for everyday life.

A large part of the National Curriculum for all 5–16-year-olds is still based on the traditional primacy of physics, chemistry and biology as specialist subjects and the rigidity of timetables has confined teaching approaches, with no time to digress and follow up individual interests. The National Curriculum essentially prepares pupils for GCEs, although only about 25 per cent proceed to these levels. General science does not rate much kudos it has to be A and AS levels, leading to BTEC HNDs in Further Education (FE) and/or to Higher Education (HE) degree level. There has always been a strongly vocational emphasis on the goals to be achieved, to the highest feasible level of qualification, primarily for research practice with even teacher and technician roles seen to be somewhat off the main track. As with medicine and law, science-based education seems to be for other people and only the privileged clever few at that.

Consequently, in contemplating returning to study, or seriously investigating the science behind events, adults' confidence is often shakiest. Often, this lack of confidence is conveyed to others in their families, particularly younger generations. Too many parents are heard to say, 'Don't ask me to help with science homework – I hated science at school'. Even people who can add up supermarket bills upside-down, calculate betting odds or build rockets in their back garden, say that they 'can't do maths' and 'found science boring'. Computerisation has taken the drudgery out of number-crunching but at the same time it has pointed out the need to understand maths as a means of expression, to interpret orders of magnitude, measurements and other data. The Moser report *A Fresh Start: Improving Literacy and Numeracy* in 1999 identified that about one in six adults continue to struggle with functional literacy and about one in four with numeracy. By extension this must also limit wider participation in the sciences.

The Government's National Strategy for Literacy and Numeracy initiates not only a high-profile campaign but also focuses education providers on identifying and supporting basic skills needs in all learning contexts, with resources provided to improve the situation as a matter of urgency. A similar concerted approach to learning in and about science is also needed, to enhance the delivery of teaching and learning and extend levels of knowledge of basic science and use of data, as an important aspect. The new national Learning and Skills Council (LSC), within its remit from the Secretary of State for Education and Employment, is responsible for raising the demand level for education and training, setting and monitoring national targets to increase participation in learning. Sadly, the only target relating to adults is focussed narrowly on attainment of qualifications equivalent to NVQ level 3, and generally improving literacy and numeracy, without specifying any benchmark measurements for learning participation overall. This is less than the adult learning target previously set in the early 1990s and will not measure the effectiveness of the LSC's work in meeting the aspirations of the full range of potential adult learners.

The main issues are even bigger than that, however, and it is essential to know more about what the public thinks and believes, in order to provide relevant knowledge, understanding and information. There are real social, environmental and economic choices to be made, in order to create the kind of world we all want to live in. The application of science and technology must be seen in the context of the moral and ethical values held by the majority

Cafés/Bars des Sciences were first set up on France in 1997, as places where for the price of a cup of coffee or a glass of wine people meet to listen to a speaker and to discuss ideas and developments in science and technology. There are now between 20 and 30 in major cities and they are open to all who are interested, with no formal membership procedures. Some Cafés were started through the Société Française de Physique (SFP), some through the Centre de Culture Scientifique, Technique et Industrielle (CCSTI), some through 'Clubs Sciences et Citoyens' (CNRS) and some through the initiative of journalists, students and teachers. They all aim to establish a dialogue between scientists and citizens in a convivial atmosphere, some citizen-led, with open public debates on nuclear energy, pollution, genetic modification and so on and some via more classic science popularisation with lectures by specialists on art and science, quantum mechanics and other subjects. In 1998, a Café Scientifique was founded in Chapel Allerton, North Leeds, on the initiative of a media programme producer in science. Most of the people who attend are non-scientists but the café has also attracted scientists from laboratory and university environments into this relaxed public arena. For Science Week in March 2000, a series of talks and debates was held on *Science and Democracy*, *Science and the public*, *Science and the press*, and others. The Leeds Café has been followed by one in Nottingham and both were represented at the first annual general meeting of the movement, held in Lyon in 1999.

of citizens, in order to elicit public support. Scientists need to discuss their knowledge and methods with the public in order to reach 'on-balance' decisions, within agreed values of the wider community. They need to explain their work in ways which are clear to non-experts and are seen to be relevant to everyone's lives. This is especially necessary as scientists are themselves members of the same society and should take part in that wider debate.

Overall, however, there are some fundamental barriers to public participation in science debates, and these can be identified broadly as divisions between:

- public and private knowledge;
- the public and academics;
- the arts and the sciences;
- scientists and everyone else.

The resolution of these differences has to be achieved through more and better learning opportunities in different programme modes, with flexible entry points at different levels for different purposes and choices. The science author Colin Tudge said recently in the *New Statesman*, 'We need a different kind of science education. Science should not be taught simply as an apprenticeship...but as a significant slice of cultural history and a way of looking at the world.'.

Much has been written recently about the learning society and the need to cultivate human resources as the most valuable asset in developing communities both socially and economically. Of course, the development of 'human capital' solely is not the whole answer, but needs to be supported also by investment in physical plant and infrastructure, including education and training. However, as scientific discoveries and processes have provided healthier and wealthier lives, more people can help to extend the knowledge further, to a wider population in more countries of the world. But more people must have better access to learn about science in order to steer new technologies ethically and wisely.

While there is a general acknowledgement that dealing with change is primarily a learning process, there tends to be an assumption that education about science and technology must be concentrated in schools and for young people, so that resources should be applied here predominantly. Indeed, the House of Lords *Science and Society* report mentions adult education only once, and then vaguely, in relation to the need to focus especially on women in their role as mothers and grandmothers of the younger generation – their Lordships seem to be unable to break away from stereotypical perceptions even here! But this approach ignores the role of adults needing to deal with immediate change, both structural and personal, whether as workers, family, community or cultural leaders, and overall as responsible tax-paying citizens.

In 1995 the European Commission (EC) published a thoughtful policy paper *Towards a learning society: teaching and learning in the twenty-first century.* This acknowledged the need to forge a cohesive and active society in Europe by encouraging the valuing of cultural diversity and active citizenship, and the need for access to broadening programmes of learning alongside the development of technical and vocational skills for individuals' employability. Among other issues, the EC emphasised that it is in everyone's interests to pursue the goal of providing a breadth of learning opportunities for all, stating that education and training are worthy of long-term investment of resources, and should be encouraged with fiscal incentives for everyone to buy-in.

For the UK particularly, the Further Education Funding Council's (FEFC's) Widening Participation Committee, chaired by Helena Kennedy QC, made similar points. In its report *Learning works* published in 1997, the Committee stated that while the rationale of

the need to develop the skills base for economic regeneration was incontrovertible, it was by no means the only reason. Wider purposes of social inclusion and cohesion are even more important for the longer term, and there must be justice and equity within educational growth, which is primarily funded by the public purse. The need for much more substantial investment of resources in all forms of learning was emphasised, pointing out the substantial role of both Further Education (FE) and broad Adult Education (AE) provision, in total supporting much larger numbers of learners but at much lower per capita funding than applies in Higher Education (HE).

In 1997, the newly-elected Government for the UK set up the standing National Advisory Group for Continuing Education and Lifelong Learning (NAGCELL) under the Chairmanship of Professor Bob Fryer. In 1998, with the consultative work and advice of NAGCELL, the Government published its Green Paper *The learning age: a renaissance for a new Britain* (for England, followed soon after by *Learning is for everyone* for Wales and *Opportunity Scotland*). These papers set out all the social and economic reasons for building the UK's human capital, to foster enquiring minds and a love of learning, drawing on people's creativity and imagination as well as enhancing their knowledge and skills. In his Foreword to *The learning age*, the Secretary of State for Education and Employment said,

> 'To cope with rapid change and the challenge of the information and communication age, we must ensure that people can return to learning throughout their lives. We cannot rely on a small elite, no matter how highly educated or highly paid...learning has a wider contribution. It helps make ours a civilised society, develops the spiritual side of our lives and ...enables people to play a full part in their community.'.

The subsequent White Paper *Learning to succeed: a new framework for post-16 learning*, published in June 1999, followed by legislation enacted during 2000, set out the Government's aim 'to place the learner at the heart of the (education) system'. To do so, the system has to become more accessible to all potential learners and therefore less fragmented in planning, resourcing and delivery. For the first time, there is now a single national authority, the Learning and Skills Council (LSC), supported by 47 local LSCs, responsible for the funding and delivery of all post-16 education and training outside HE. Since April 2001, this structure has replaced the Further Education Funding Council (FEFC), the Training and Enterprise Councils (TECs) and the National Advisory Council for Education and Training Targets (NACETT). The LSCs involve education and training providers and users, relevant statutory and voluntary agencies, business and commercial interests, and they open up opportunities to a wider range of agencies to propose a wider variety of learning programmes, the main objective being to raise the demand for lifelong learning overall. There are Local Initiative Funds for LSCs to support not only enterprise-related learning but also community development and capacity-building. Where they exist, Local Learning Partnerships are also a key link with LSCs for planning and overseeing delivery of learning programmes responsive to the local community. Additional public funding has been allocated to this end.

The national LSC, which is supported by a specific Adult Learning Committee, is responsible also for quality assurance, conducting new inspection processes in adult and community education, and for liaison with Learndirect (formerly headlined as the University for Industry, Ufi). Learndirect's remit is to extend the range and delivery of on-

line, interactive and distance learning through the Internet, potentially in combination with the reach of the broadcasting media directly into homes and workplaces. Initially, Learndirect has targeted skills-based and work-related learning for employees, with over 100,000 learners signed-up in its first two–three years. It offers direct, publicly accessible advice and referral services for educational information, advice and guidance and by Adult Learners' Week in May 2001 had responded to 2.5m telephone helpline calls. While nationally coordinated, Learndirect operates via regional hubs linking about 500 Local Learning Centres.

The Government has stated its intentions to invest in learning to benefit everyone, to lift the barriers to participation across the whole range of learning, and to eliminate the divide between education aimed at vocational ends and broad non-qualification bearing learning. The need to make the qualifications system more learner-friendly and less rigidly compartmentalised is recognised, by means of shorter, more flexible bits of learning which can accumulate credit as an option to be invoked by the learner. It aims to encourage partnerships among a range of agencies concerned to widen participation, and to achieve a more effective range of learning provision in total, as well as aiming to increase the numbers in AE, FE and HE. Recognising that we need to find better ways of funding learners, Individual Learning Accounts have been introduced, open to contributions by Government, employers and individuals. The first million of these are now being developed, although only in relation to work-related learning so far, with a Government contribution of £150 for each individual learner contributing their own £25 stake. Under the scheme, FE providers can offer substantial discounts on fees for qualification-bearing courses, especially IT-related, and claim reimbursement from public funds.

These developments are all still relatively new, however, and it is essential to ensure that coordinating agencies and learning providers hear the voice of the learner in their planning. The public needs to be well informed about their different roles and accessibility. Potential learners need to know what information and support mechanisms are in place, and to develop the confidence in using them, especially if they are newly returning to study and have not had good experiences from the education system earlier. The emphasis has shifted from the priorities of the education supplier to the potential demands of the learners, from a relatively narrow band of participation to a more socially inclusive canvass, from the location of the providing institution to local delivery in community-based learning centres, with learning agenda relevant to the communities they serve. The Government has set out a vision encompassing all forms of learning, from basic skills to advanced scholarship, from learning for interest and fun to continuing professional development.

While the value of formal study programmes for qualifications continues to be recognised, so is the value to be obtained from non-formal means such as in-house work-based training, learning programmes provided in the context of voluntary activity, or by adult and community education services. Informal and experiential learning by doing, or by exchange within the family or local community environment, is acknowledged to be positive and useful, whether achieved through self-selected reading, watching television, or following a hobby. All are valuable as part of a more holistic approach. Finally, the message has dawned that building on people's own interests, concerns and choices encourages a positive commitment to and confidence about learning processes generally and the positive effects of both non-formal and informal learning for personal development have been re-discovered.

At present, however, the science curriculum is too narrow and restrictive, concentrating on the retention of a high volume of factual knowledge, rather than encouraging exploration. This is certainly one of the factors causing a lack of enthusiasm for pure science subjects. Yet learning in and about the sciences, as well as the arts and crafts, has to be concerned with the understanding of different thought processes, histories and cultural influences, as well as the acquisition of factual knowledge and technical skills. Everyone, at whatever age and stage of their lives, is entitled to explore their own purposes in learning about science and to develop their own confidence in thinking critically about the implications of science for society. The most important common factor is that all learning offers opportunities for discovery, opens up new directions and is enjoyable, as most of us who have already benefited can testify.

These issues around lifelong learning are well recognised by education researchers and practitioners concerned about science teaching and learning. In 1998, the Nuffield Foundation funded a seminar series *Beyond 2000: science education for the future* which recommended a wider science curriculum for ages 5–16, primarily aimed at enhancing scientific literacy and learners' ability to understand and interpret scientific information and ideas. In 2000, Robin Millar of the University of York published a paper describing a new course on *Science for public understanding* for 16–18-year-olds. In 1994, the Association for Science Education (ASE) established a Post-16 Science Study Group. This explored a more integrated approach to teaching and learning as a continuum which includes adult and continuing education as well as the National Curriculum and its examination levels. Within the Group's report, there are many examples of imaginative and supportive practice in science within broader adult education settings. Unfortunately, these tend to be isolated and unconnected examples, rather than providing a spectrum of learning opportunities to enable people to participate at any stage relating to their own interests. The analogy drawn by Diana Bentley and her colleagues in their draft report for ASE *Open science: lifelong learning through science*, is more like 'a conveyor belt which enables most people to fall off it at various stages and few to clamber back on'.

It would be unrealistic to suggest that science education *per se* could and should be used as a prime tool to increase participation more widely. On the other hand, access to learning in the sciences is an equally valid goal of Return to Learn programmes and should be part of the array of choices offered flexibly to meet the needs of potential learners, from absolute beginners to those previously experienced wanting to update or explore new directions of interest. The main objective must be to encourage more people to see themselves as continuing learners throughout their lives and to encourage their interest to extend to whatever advanced level they find feasible. The lifelong learning agenda aims to put people first, with the statistically sound concept of making the best of the most, thus reversing the previous restriction of making the most of the few.

There is no hard and fast age-limit defining adult learners. In some contexts, they can be everyone over the minimum school leaving age of 16, but on the other hand there has already been considerable concentration on education provision for 16–19-year-olds. In Higher Education (HE) institutions, 'mature students' means anyone over the age of 21 at entry, but with increasing popularity of 'gap' years, or other forms of developing experience and knowledge for the age group 18–21, this hardly seems to constitute a special category.

Motivation and experience add definition to the age ranges, broadly along the lines of:

- 16–25-year-olds, who are essentially vocationally driven, continuing their initial education;
- older learners aged 25+, who are also vocationally driven, to improve qualifications, gain new ones or to change direction for employment;
- older learners aged 25+, especially those aged 60+, who are not necessarily focussed on vocational qualifications and/or employment.

Adult learners are really defined as those who have had a significant break from their initial education, do not see their learning to be a consecutive age-related sequence and wish to return to studying for new purposes in a changing world, at any age from about 25+. For them, learning is not necessarily a solitary or subject-led experience, but is more about fulfilling curiosity, often in a sociable group sharing the excitement of discovery, pursuing their interests as far as their own aims and talents allow, regardless of whether they end up in the compartments of Further Education (FE), HE, Adult or community-based education. In addition, adult learners are usually more committed and well-motivated in undertaking their own choice of learning for their own purposes and from their own resources, than are the straight-from-school younger learners. Adults bring their own experiences

and developed 'common sense', and are often more able to study in a multi-disciplinary way, better at lateral thinking and problem-solving.

Over the last ten years, student numbers have increased dramatically in FE and HE from about 3.4m in 1990 to about 6.1m in 1999. There has been considerable emphasis especially on increasing the numbers of school-leavers, steered by funding methodologies into vocational FE and HE programmes and since 1992, the age-participation rate of 18-year-olds has increased from fewer than one in ten to about one in three currently. In addition, there has been substantial growth in 'mature' students, over 21 years of age at entry, mainly wishing to study part-time alongside family and work commitments, and part-time adult learners now comprise the major proportion of the FE and HE student population. For many, formal Foundation or Access courses in science have been helpful in bringing them up-to-speed in knowledge required for career-development purposes.

Despite the overall expansion of the FE and HE system, the numbers taking up science subjects continue to be relatively low, and enrolments in courses in physics and chemistry especially show a persistent decline. In 1998/99, the numbers of students in the total of FE and HE courses in physical sciences amounted to about 3 per cent of the total full-time enrolments and about 0.6 per cent of part-time, with the major proportion being in HE. This does not include, however, many for whom there is a science component within courses dedicated to other vocational goals, such as hairdressing, diet and nutrition, construction or vehicle engineering, for example.

Within this overall increase, there will be marked differences of participation in relation to age, gender, previous educational achievement and where people live, among other factors. NIACE surveys of all post-16 learners across population samples continue to show that almost 40 per cent have not engaged in any learning at all since they left school, and about 60 per cent are unlikely to plan to take up learning in the future. Previous educational achievement is a strong conditioning factor, with those educated to the age of 18 and beyond tending to return for more, whereas those who finished their education at age 16 or younger tend to stay away. Participation is strongly influenced by social class with those in classes AB returning more frequently than those in classes C2, D and E. There are variations depending on the regions in which people live, but even more so between those living in urban environments with better access to learning centres, compared to those in rural environments where people have to travel farther with less frequent and convenient public transport.

Participation declines sharply in older age, especially for those over 55, reflecting the long period of concentration on steering the younger generation into vocational skills for employment. On the whole, more men than women are involved in learning, especially as women still have relatively fewer opportunities to return to learning after school and men continue to be offered more opportunities in the context of paid employment. While women make up a substantial proportion of enrolments in adult and community education provision, they are less likely to join in qualification-based courses and particularly less likely to choose FE and HE courses in science subjects.

From NIACE survey work, however, it is clear that there is a substantial commitment to learning about information technology (IT) and its applications among the middle-aged and older age groups, persisting healthily past conventional retirement age. When asked

specifically about their choice of subject, over 30 per cent of those aged 50+ were taking IT courses compared to 14 per cent of 17–24-year-olds. However, only about 5 per cent over all age-groups were studying in the sciences, maths or statistics as subject areas, dropping to 2–3 per cent in age groups from 50 onwards, compared to 10–13 per cent across the age group 17–24. Of course, we cannot easily measure how much these participation levels are confined by the limited provision of relevant courses on offer, the lack of open access without previous qualifications, and what other choices they might make if there were more options about subjects and modes of study, length and pace of courses. More detailed data from NIACE survey work are set out in Appendix 3.

Sheffield College offers formal Access to HE programmes for mature students who may not have traditional examination qualifications but wish to return to study. Over 700 students were enrolled on Access courses in 2000/2001. The courses are modular, with flexible timing of attendance on a daytime and/or evening basis, over one or two years or longer if required. Modules can be taken by those who wish to improve their knowledge and understanding of life sciences whether or not for progression to advanced vocational programmes. Credits are awarded at levels two and three, validated by the Open College Network.

Examples of specific programmes are:

- Access to Health Science and Nursing Access Course, with a choice of subjects including Chemistry, Biochemistry, Cell Biology and Physiology;
- a broader Science Access programme with subjects including Chemistry, Physics, Biology, Environmental Science and IT, as well as Maths.

Financial support is available for people receiving benefit payments or otherwise struggling to pay course fees. Childcare support is offered via the College nurseries, with financial support towards fees, when needed. Explicit support is offered to learners with disabilities.

The College has already established a generally accessible Website, to share information, and is developing *Science on-line* learning provision available via the Internet, with the first unit in Chemistry I/Radioactivity being piloted and two more soon to be available, on Biochemstry I/Proteins and Nucleonic Acids, and Physiology II/Genetics. The College sees this as a means of extending access and widening participation by means of a distance learning mix, for the future.

Discrimination clearly persists in relation to older people, particularly affecting their lack of opportunities to pursue new directions in learning. It is assumed, erroneously, that they are beyond the point when they can benefit from the same broad range of educational opportunity as younger generations. It is not always acknowledged that they are able to teach the rest of us a thing or two, extending their accumulated knowledge and experience to the benefit of their families and communities. NIACE, within its Older and Bolder initiative, has demonstrated how much needs to be done to change this, particularly given

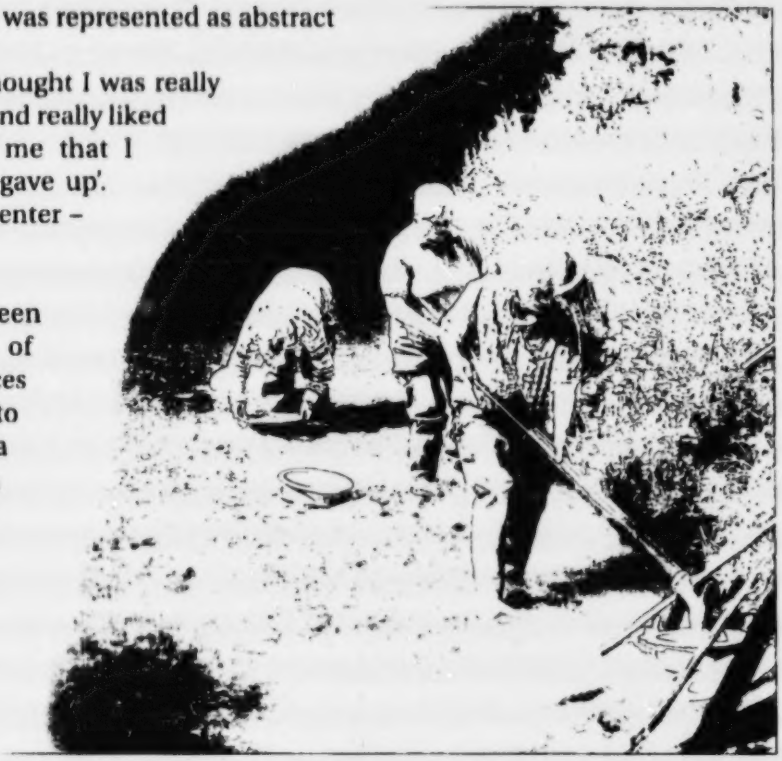
the current demographic shift towards an older population, with people living longer and healthier lives. Within the government's Better Government for Older People programme, concentrating on ways of improving support services for older people, access to learning was recognised as one of the integral functions enabling their positive inclusion in a modern society.

There is every need to consider positively how older people can pursue their interests in science and technology further, not only a matter of equity but also for the benefits they can bring to the community. Many of them will have existing experience and perhaps qualifications relating to science and technology, and perhaps have already fulfilled a lifetime of working in a technical environment. Many could fulfil other useful volunteer roles, including mentoring others in science learning or technical work roles. Many could take on professional development in new specific job roles, whether for new full-time or part-time work, including training as potential teachers or as volunteer classroom assistants.

The views of women on and in science give an interesting focus on many of the apparently alienating features of science and science education. In 1992/1993 Jean Barr of the University of Glasgow and Lynda Birke of the University of Warwick conducted interview-based research with about 40 different women, with ages ranging from 26–66, and of whom 12 were black African, Afro-Caribbean or Asian. All had chosen to return to learning, some in vocational study programmes others in broader cultural studies, including six enrolled on the Women and Science course at Coventry University. A key view expressed is summed up by one woman's comment, 'Science is everywhere, yet it has nothing to do with me'. A strong theme emerged about the tension between women's everyday lives, their technical knowledge which is viewed as simply 'applied common-sense' and the lack of respect for their views and work, still assumed to be primarily in domestic disciplines. Yet women express an interest in and concern about science, recognising its potential benefits but also its inherent risks, and wanting to know more about it in order to understand how it affects their lives and their families. Many of them had not enjoyed their experience of learning

The University of the Third Age (U3A) is a national network of older adults no longer tied to employed work and interested in following their own choice of learning. They will certainly be over 50 years of age and most likely over the conventional retirement ages of 60 for women and 65 for men. They continue to pursue their own choices of active learning in self-help study groups, interested in learning for its own sake. In the UK, since the movement was established in 1982, it has grown to over 75,000 members in about 7,000 local groups, and covers about 250 different subjects. Groups organise their own subject leaders or tutors, for informal learning sessions held in each others' homes or in space rented from local colleges or community centres, so that costs are low for members. The U3A has formed a Science and Technology Network, with a regular newsletter sharing information on subjects of interest, activities or events, and organising group visits to sites of special scientific interest – or even SSIs!

science at school, where it was represented as abstract and difficult.
One interviewee said, 'I thought I was really good at science at school and really liked it. But my teacher told me that I wasn't really good...I just gave up'. Another saw it as 'Do not enter – restricted area'.



Although there has been considerable study of gender-bias in the sciences and much has been done to counteract its effects, a positive action approach is still needed. Girls and young women are demonstrating greater achievements in school environments, but for adult learners there continues to be an argument for women-

The National Space Science Centre, with Leicester Adult Education College's LiveAge project, embarked on planning ways to involve older people, their skills and experience, in the work of the new Centre right from the beginning. Long before the Centre was opened in June 2001, the idea of planning a special week in September was launched with local community representatives in the project's network, to identify roles and activities which older people could share as informal learning opportunities. The Centre set out with the intent to offer experiences which could interest all generations of visitors, from youngest to oldest, and wanted these to be as participative and interactive as possible. The strength of Leicester University as a long-established leader of academic research, especially in astronomy and astrophysics, afforded a local background of interest in related knowledge and experimentation. The older generations' knowledge of local industries, such as textiles manufacture, aerospace and materials engineering, or flight navigation and instrumentation, was clearly relevant. Other activities planned to take place at community venues were envisaged as extending into art and design, literature, health or technology advances generally, in order to develop localised projects on space-science themes. The potential for older people's reminiscences and story-telling was valued as a resource to reinforce the excitement of the beginnings of space exploration, reflecting an active role for those involved from the 1950s.

Coventry University's Centre for Engineering and Science Education offers a Science and Engineering Foundation course targeting mature learners without formal qualifications. The Centre has organised taster sessions, access to learning in ICT, public lectures on science-related subjects, provided learning support in visits to industry, and worked with teachers supporting parents and family learning groups in local schools. In 1999/2000, the Centre attracted a substantial European Social Fund grant to offer an Access to Science programme targeted especially at women, particularly from local Asian and Afro-Caribbean ethnic minority communities. About 220 women benefited from this approach. The Centre aims to provide learner support including childcare, financial assistance and opportunities to study at their own pace, whether on part-time or full-time programmes.

only programmes, relevant to their own expressed interests and cultures, as an option to encourage greater participation.

The WISE and WIST initiatives (Women into Science and Engineering, and Technology respectively), supported by the Engineering Council with some HE institutions, have provided some good role models and examples of good practice in developing study programmes which are more attractive to women learners. The Department of Trade and Industry (DTI) report *Breaking the mould* gives an assessment of successful strategies for attracting girls into science, engineering and technology, although overall they have not achieved big increases in numbers enrolling on programmes year by year. In 2000, the Women's National Commission, established by the Government several years ago and based in the Cabinet Office, set up a Women's Science Forum (WSF), drawing on women scientists from many statutory and voluntary agencies (including several educational institutions and the National Federation of Women's Institutes). WSF is concerned to ensure a voice for women in policy matters relating to science and to promote the advancement of women in applying science and technology for the improvement of quality of life for all.

Drome Ty Avow is a voluntary project aiming to support access to learning for the unwaged, especially women. Based in Wrexham in North Wales, it has close connections with all the local authorities and colleges in the area. The project's experience shows that women see science as a 'man's area' of learning and that they are worried about 'showing themselves up' in a mixed class. Among other learning support, the project offers a free-of-charge, part-time beginners course, Return to Learning in Science as women-only provision. The course is accredited at OCN level one and offers progression to other science courses at OCN level two.

For women working in scientific or technical environments, the classic employment hierarchy prevails, dominated by men in senior and powerful positions. Even when present in large numbers, women are often perceived to be support workers without attribution of their real skills. This is especially the case in research-based working environments, whether industrial or academic and is corroborated by recorded history, in which the contributions of women scientists are so rarely mentioned. In 1996, United Nations Educational, Scientific and Cultural Organisation's (UNESCO's) *World Science Report* highlighted a continuing problem of gender discrimination in relation to educational, research and policy environments. When women scientists are celebrated, the record is expressed in terms of amazement that they can do it at all, and often the phenomenon is attributed either to the support of an even cleverer male colleague, or to the omission of child-bearing and so due to unnatural causes! At the same time, many women are often uncomfortably subject to the views of male experts, in medicine, in IT or in connection with technical equipment or machinery. The expertise claimed is not always sympathetic, beneficial or appropriate in its application, and yet there is positive discouragement to question the wisdom of the expert.

Many locally-based adult and community education providers, despite their good contacts and practice in providing for local communities and groups, find it difficult to attract men, both younger and older, to return to learning. Taking a positive view, however, many see their engagement with family groups as particularly beneficial, encouraging adults to take up learning opportunities by building on the interest of parents and grandparents in their children's progress. At the same time, families have fun learning together, combining sociable activities with serious group learning.

People with learning difficulties and/or disabilities usually experience a lack of respect for their aspirations and potential in relation to science learning, although the recent enactment of anti-discrimination legislation in relation to disability will enable solutions to difficulties which are often perceived to be greater than they are in reality. There is a tendency to lump everyone with a disability together, as though some uniform response is required, rather than considering with individuals how they might interact more positively with the scientific environment, but on their own terms. Often, the first obstacle to participation is cited as health and safety requirements, as experimental environments,

WITEC (Women in Science, Engineering and Technology) is a European network of organisations working to support and promote women working or aiming to work in advanced scientific and technological fields. The network was established in 1988, based in Sheffield Hallam University, and is funded by a variety of EC programmes including Leonardo da Vinci for training programmes, plus the DTI in the UK. There are partner organisations in nine other countries, specifically Ireland, Germany, Spain, Italy, Greece, Belgium, Finland, Sweden, and the Netherlands. Since 1995, the network has offered short courses, for periods from three to ten days, on themes such as IT Updating for Qualified Women, IT Flexible Working, Positive Personal Attitudes and Effectiveness for a Successful Career Path, Equal Opportunities for Career Advisors, Mentoring, and Multimedia Authoring.

Newcastle-under-Lyme College established Chesterton Community College as an outreach location in Staffordshire, in an area of Single Regeneration Budget status, aimed at revitalising the local economy following the decline of the coal mining industry. Chesterton offers creative family learning activities to encourage parents and children to support each others' learning and to attract adults into other educational programmes. Particularly in National Science Week, held annually in March, the College has planned, in partnership with local community groups, churches, schools, FE and HE providers, to offer free-of-charge workshops, games, hands-on 'make-and-take' activities and exhibitions of work in a variety of accessible venues such as schools, churches and village halls.

Events are well-publicised in advance and each year has a theme: in 1998 exKITEment was about the science of kites, establishing an ongoing annual kite festival in the Apedale Country Park. In 1999, over 500 people of all ages joined in Spaced Out focusing on astronomy. Activities included creating a giant wall hanging of the planets to scale, making new board games about space, making electronic LED-lit constellations of stars and locating the Starlab planetarium in Chesterton High School. There was story-telling in the local library, and a Science Communicators' award with points given for imaginative posters, ways of telling friends and family about events, making display models and helping with workshops. The Basic Skills group from Chesterton Community College visited the local Newchapel Observatory, and three groups visited Jodrell Bank as a linked family learning outing.

The benefits of the programme are seen to be:

- bringing science to a wider audience, especially in the context of urban regeneration;
- offering science education in informal, non-laboratory environments;
- involving all age groups, with opportunities for intergenerational learning;
- raising the confidence of adults about local opportunities to learn generally and about science topics in particular;
- raising the profile of science-based projects and engaging ongoing interest in the community projects more widely;
- forging partnerships of local education providers and community groups;
- promoting a user-friendly image of education providers.

Number Crunch was the focus for Maths Year 2000, with Bodyworks linking science with health education for 2001.

whether field or laboratory-based, chemical or physical, are by definition hazardous for everybody to some extent. But just as people with learning difficulties and disabilities identify means of support in relation to housing, traffic, transport and the world of education or work generally, the most advanced scientific and technological attention must be brought to bear on their entitlement to access to science studies.

Cultural background and ethnic origin also influence the way people see science and scientists. There is a preconception in the Western World and the Northern Hemisphere that science is primarily American and European, without distinguishing between the regional dominance of resources and wealth for research, and the balance of needs and knowledge in other parts of the world. There is a tendency to forget that before the Renaissance in Europe, the Arab world had already invented algebra and astronomy, that some of the most crucial medical research takes place in Africa and India, and that Bombay is an excellent centre of software design and engineering.

For many religions and cultures, such as Islam, there is at least a two-fold concern. On the one hand, there is anxiety that the subject boundaries of science prevent a more holistic view being taken of research, development of applications and the connections which need to be taken into account in assessing the impact of new discoveries on people and the natural environment. Secondly, there is concern that the Eurocentric bias of science and technology obstructs the practice of other cultural mores, whether in relatively simple ways such as providing opportunities for prayers and rituals, respecting dress codes, more seriously about handling animals and materials, or providing for women-only groups. For many potential learners, there needs to be respect for all forms of life. It is not sufficient to say that the purpose of research is to experiment, analyse and record, without taking into account the moral and ethical judgements involved in putting new discoveries into effect. There is a cultural view that the relationship between science, scientists and social responsibility needs to be seen as essential and not optional.

Learners from black and other ethnic minority communities are often not attracted by the traditional approach to the science curriculum. Although many, particularly from Indian and Asian backgrounds, are keen to enrol for programmes relating to medicine, IT and maths, numbers participating in physics and chemistry are relatively low. There are relatively few black teachers of science as role models. The Teacher Training Agency (TTA), however, is committed to projects and initiatives both to raise the attainment levels of pupils and to increase the recruitment and retention of teachers from black and ethnic minority communities. A research report published in March 2001 showed that among a statistical sample of black and ethnic minority PGCE students, there was a high level of commitment to teaching as a profession. Of the total sample, 75 per cent were women, about 30 per cent were 'career changers' and 25 per cent had a first degree in science. The report demonstrated that ethnic minority communities provided an important source of recruitment for secondary school teachers in shortage science and maths subjects.

Teachers, whether in initial or in-service training (INSET), are also adult learners. The planning and provision of science-qualified teachers is a matter of urgency in view of the current serious shortages (more than 40 per cent) in secondary school physics, chemistry and maths especially. At primary school level, only about one in three teachers has their own subject knowledge in the sciences, although this ratio should improve as all trainee primary school teachers now have to have GCSE or equivalent science, with a reasonable level of up-to-date knowledge. Despite government inducements, such as the 'fast-track' scheme for trainee and experienced teachers, the number of science-based graduates taking up teacher training places is still too low, although there has been a significant increase in postgraduate science teacher training applications between 1999/2000 and 2000/2001. The Government is aware of the need to strengthen investment in continuing

Coleg Glan Hafren in Cardiff offers an Access to Life Sciences programme which is open-entry, modular and flexible, with the opportunity to mix module choices across social, life and physical sciences. This one-year intensive course normally enrols about 15 mature students, ranging in age from 21 to late 40s, with an even gender balance, and a wide range of ethnic origins. The course is comprehensively marketed in its local area, where there is a high level of unemployment and therefore financial disadvantage, especially among the black and ethnic minority communities.

The 1999/2000 course cohort acted as a focus group to feed back their views on access to and participation in science teaching and learning. The group expressed strong views and the women were more vocal than the men, particularly those from an ethnic minority background. Those who do participate in learning about science were thought to be mainly people who had achieved academically at an earlier stage and wanted to change direction, and middle class ethnic minority women whose husbands think science is a worthwhile and suitable profession. Access to science was thought to be especially difficult for: single mothers and relatively new parents, at a time of pressure in their lives and needing childcare support; older people intimidated by stereotypical images about their capabilities; women from minority ethnic communities for whom lack of a supportive partner was a barrier in itself; disabled people who might need specific additional learning support. The main barriers to access were thought to be: the daunting nature of fast-changing technology: 'science is very intensive; science is intimidating'; fear of failure; especially fear of maths; lack of money; family responsibilities; narrow-minded cultural attitudes.

The benefits of attracting people into science were thought to include: broadening options for life choices; science-related jobs meaning better jobs and professional roles; people questioning science and technology from an informed standpoint; learning about science brings out a passion in people. The disadvantages of not attracting people were thought to be: not understanding decisions made about your future; not producing skilled people; dead-end jobs for life.

Learners could be better supported by: financial incentives (to be offered by Government and employers); work experience; the science industry providing mentoring for those returning to learn; science companies participating in loan/bursary schemes; more taster opportunities, especially in user-friendly voluntary sector education provision; a kinder/softer media image. Teachers could be better supported by: a national access curriculum; recognising that science returners need more time allocated to the curriculum; sensitive timetabling to allow for family and work responsibilities; training in how to deal with adult learners; better teacher training in schools.

professional development for teachers and is piloting a strategy focussing on science teachers of 11–14-year-olds.

High quality science-related INSET is available to encourage development and up-dating of professional skills with a science content, but access is limited, especially by pressure of teaching timetables and the difficulty of obtaining supply cover. Many teachers already give up their own time to attend INSET activities and deserve better support for their continuing professional development. Distance learning approaches to INSET will help, including via the Internet and websites dedicated to the exchange of ideas and experiences. For teachers working with post-16 science learners, the Association for Science Education is developing NETSci as a national network for the exchange of information and sharing of good practice via a dedicated Website, monthly e-briefings supplemented by an annual national conference as well as regional meetings. The Royal Society of Chemistry (RSC) already hosts a Website dedicated to teachers of chemistry and there are Websites explaining the periodic table, chemical reaction mechanisms and other science concepts, designed to be user-friendly for everyone. Teachers' development of adult-friendly curriculum materials must be supported, particularly for the application of distance learning techniques, with time allowed for promotional, marketing and outreach activities.

Because teachers are learners too, they must be widely consulted about their own views of science teaching and learning, to establish what can be done to make the curriculum more attractive to them as well as other learners. It would be helpful to revisit and reinterpret the Nuffield Resources for Learning project, as well as the recommendations of the James Report. The introduction of citizenship studies to the secondary schools' national curriculum, from 2002 onwards, will increase opportunities for teachers to explore some of the wider social, ethical and economic issues around science. The Government, however, needs to find better ways of tackling the combination of short-term contracts, high volume workloads, heavy bureaucracy, low morale and relatively low pay among teachers generally, as well as making the curriculum for learning and teaching science less restrictive and more attractive. For the future, it is essential to enable the change of mode of teachers, from imparters of factual knowledge and imposers of examinations, to role models, mentors and facilitators of others' development of their own learning. Knowledge of science and technology is essential for a wider range of work-related functions, in addition to teaching and research. Some of the less well-known jobs are in other public services or technological industries, requiring knowledge of diverse aspects such as forensic science, veterinary medicine, food technology, pharmacy, etc. In 1997, the Department for Education and Employment recognised the Science, Technology and Mathematics Council (ST+MC) as an all-sector National Training Organization (NTO) enabled to act as an occupational Standards Setting body for member sectors that do not belong to any specific Industry Training Organisation or Standard Setting Body. It covers such occupations as research, laboratory operations, meteorology, criminal intelligence, analysis, etc.

The vision of the ST+MC is 'To become the uniting voice for lifelong learning in science, technology and mathematics within the UK'. Its remit includes raising awareness of science and technology, the development of occupational standards, conducting skills audits and identification of future skills needs, with the development of education and training to meet these. ST+MC networks with employers, other related NTOs, professional bodies, the DTIs, the Department for Education and Skills (DFES), Regional Development Agencies, and the new Learning and Skills Councils (LSCs). It has initiated a Science and Technology

Consortium to include also the trades unions and other interested organisations. ST+MC has conducted comparisons between Science GNVQs and A levels, developed Foundation and Advanced Modern Apprenticeship Frameworks, and has prepared *Maths Hotspots* and *Science Hotspots* reports identifying issues which both teachers and learners find difficult. Its publications also include *Numeracy Skills in the UK Workforce: Final Report* and *National Occupational Standards for Laboratory and Technical Activities, Level 4*. ST+MC also has a website where it publishes an electronic *e-Update* monthly.

With increasing sophistication of instrumentation and IT, it is even more important that people have some underpinning knowledge and understanding of the processes involved, in order to make informed judgements. For some years now, the TUC has set out an explicit Bargaining for Skills agenda, as guidance for specific trades unions to incorporate in their negotiations their members' entitlement to broad education as well as training. Since 1999, the Government has allocated funding to the Union Learning Fund to support trades unions in encouraging greater take-up of learning at work. The Fund will continue to be resourced until at least 2004.

Several trades unions, with substantial membership relating to science and technology subjects in both public and private sectors of work, have formed a Science Alliance, including NATFHE (National Association of Teachers in Further and Higher Education) and the AUT (Association of University Teachers), with professional interests in how science teaching, with IPMS (Institution of Professionals, Managers and Specialists, mainly for specialist staff in the Civil Service) and MSF (Manufacturing, Science, Finance). The Science Alliance aims to highlight the importance and needs of science workers, to Government, politicians and the public generally. It organises conferences and seminars, writes articles and press releases, submits evidence to Parliamentary Inquiries and Government departments, and has published a *Charter for Integrity in Science*. During past National Science Weeks the Science Alliance has held seminars on A Fair Deal for Women in Science, Engineering and Technology (1998) and Do Scientists need Lifelong Learning? (1999). In March 2000, a symposium on Race and Science was held to raise issues of diversity in science and the problem of racial stereotyping within science education and training. On science and society, the Science Alliance held a conference called Oracles or Scapegoats? in the wake of the debates about BSE and Genetic Modification, with eminent speakers discussing risk, openness and involving the public in decision-making, and also offered Is Whistleblowing in Science Really Necessary as part of the British Association for the Advancement of Science's (BA's) Science Festival in September 2000.

The narrow baseline of adults' participation in learning science is already apparent and there is an inevitable restriction on the pool of skills and talents available to the community as a whole. The potential of older learners is especially excluded if they are women, working class, retired from paid work or unemployed and, as always, compounded by discrimination on grounds of race or disability – all finding it difficult to choose a point of entry. Most people, however, do not spring directly into qualification-based education programmes without testing their own aspirations and abilities first. Their choice of learning is most productively satisfied by following their own interest in a subject, thereby building their own expertise and confidence. Learning in groups with a mix of ages and experience, valuing what the learners themselves bring to the process, should be encouraged. Teachers and tutors who can de-mystify the subject, making learning about science more rewarding for everyone concerned, are essential. The value of role models, mentors and 'buddy' schemes

should be reinforced, to develop learners' confidence and convince them that they are welcome, particularly if they are older, women, and from minority communities who do not see science as being for them.

The excitement and inspiration of discovering science should be promoted, along with the value of wider participation in learning about it. Often, it is the history of science and scientists, or the opportunity to embark on hands-on fieldwork in geology or environmental studies, that people find most fascinating, leading them to want to learn more. The revelation of experimentation, of learning by doing, is the essence of self-directed study, building confidence to go further. The teaching and learning process needs to start with the interests and concerns of the learners, rather than those of the institutional providers.

From the point of view of the learner, the distinctions between FE and HE or broad Adult Education as sectors are not particularly important. There is a healthy blurring of the boundaries between informal, non-formal and formal learning, as such arbitrary definitions are for the convenience of educators rather than learners. Those interested in learning more about a subject will sensibly blend their own informal pursuit of knowledge through reading, television and other individually used sources with more formal means, on a short or long timescale to suit their own circumstances.

Adults' entitlement to wider learning opportunities must be supported by even better information, advice and guidance, leading to better provision of educational programmes which are more flexible and accessible, with optional pathways for progression. This is an exciting agenda for the new LSCs working together with Local Learning Partnerships and the whole range of education and training providers, as well as voluntary organisations, Regional Development Agencies and others with experience and expertise relevant to the communities they serve. One of the first tasks will be to consider carefully the profile of learners in their communities, and what sort of programmes they need for personal development and active citizenship, as well as skills for life and work.

To encourage more people to want to learn about the sciences, there needs to be the widest possible canvass of demand, particularly among those who do not see science and technology as being for them. There is a major difficulty, however, in reaching those who are most wary of formal education and who are least confident about starting again. To re-engage them needs not only publicity and promotion, but also forms of teaching and learning which identify and target their own interests and concerns, and which suit those who have had lesser opportunities to learn about science in the past. To a certain extent, formal Access or Foundation courses achieve this, but they are essentially designed for those already motivated and self-selected learners rather than those who are still under-confident and unconvinced.

Providers need to satisfy the curiosity, interests and choices of new and different learners, for their own individual and community purposes. Adults bring to their new learning a variety of existing informal learning, knowledge and experience, sometimes in the sciences as well as in other subjects, so they need a whole spectrum of programme offers to choose from, mixing informal, non-formal and formal learning, and in different modes of time and place, to optimise choice. They need a framework of information, advice and clear connections among different levels of study, to move in and out flexibly according to their individual circumstances. They need taster sessions in order to dip their toe in the water without long-term commitment and they need short as well as long part-time courses to fit in with their other responsibilities. At the same time, potential new learners need to know how to seek study programmes in relation to their choices and purposes, and to feel confident about how to work through the system of information and guidance when they want to change direction.

In the main, however, people can only achieve access to learning programmes which providers choose to offer and are able to resource. While there are some good examples of interesting programmes with real open access for learners to pursue learning about science, these opportunities are few and far between. Often, they are literally difficult to get at because there are few providing locations, or the timetable conflicts with work or family commitments, or access to transport. Among disadvantages for providers there tends to be low recruitment locally, so that there is a danger of course offers not reaching economically viable numbers, unless they can be aggregated into larger groups in specialist centres able to offer access cost-effectively – although, paradoxically, small groups are welcomed as a positive merit educationally, and are particularly appropriate for learning in science.

The lack of access to laboratory space and equipment and the high costs of acquiring and using such specialist space, equipment and technician support are seen to be distinct barriers to access. On the other hand, the specialist environment can be a psychological barrier in itself, compounding learners' fear of anything which appears to be 'hard' science.

In summer 2000, NIACE contacted a range of education providers, in order to obtain their views about learning opportunities in the sciences. While there was continuing concern about the shortage of resources available to develop more and better lifelong learning opportunities, there was widespread recognition of the value of encouraging wider participation in science programmes, especially through more open and non-formal provision. There was also positive appreciation of the value of supporting small groups in open, informal and self-directed study, involving peer group review and assessment of progress. The value of informal access points was also recognised, such as the idea of science shops, or the short residential courses offered by the 26 specialist colleges distributed across England and Wales, and linked through the Adult Residential Colleges Association, or the events and activities offered by the British Association for the Advancement of Science (BA).

Of course, there is a huge range of informal learning going on when we take account of what people acquire by means of their own reading, cultural visits of all sorts, watching television and listening to radio. Libraries, museums and art galleries, zoos and the newer science centres, such as the Lottery-funded developments in Birmingham, Leicester, Rotherham and Glasgow, are among the most accessible and flexible providers of informal learning. They give learners time and space to browse, to pursue their own interests at their own pace, able to stop, go back a step or accelerate according to their own baseline of knowledge, experience and learning goals. This is aided by opportunities to observe or handle specimens at close quarters and by the increasing sophistication of display and explanation

The Victoria and Albert Museum, in Autumn 2000, put on an exhibition entitled More Than Meets the Eye to demonstrate the interplay between artistic expression, scientific understanding and technological innovation. This was devised with the Royal Society and *Nature* journal, and was launched in September as part of the BA's Creating Sparks festival, involving the other South Kensington Museums for Science and Natural History. The V&A exhibition, which attracted commercial sponsorship, was designed as a self-guided tour around the museum galleries, discovering examples which included making things in different technological materials, whether layers of pigment or the silicon chip; music as sound vibrations, with instruments made from traditional and new materials; sexual display in wildlife or fashion; patterns in nature and manufacture; colour in different media; biomimetric design in built structures drawing from natural forms. The guide, written by science writer Philip Ball, started 'Science is not just a series of discoveries...Scientists have to paint a mental picture of the world, stimulated by their own imagination, which helps them make sense of experiment and experience. This is just one way in which doing science, like making art, is an act of creation.'.

techniques with the use of ICT to provide interactivity with information as well as virtual experiences. These institutions need sustained planning and resources to fulfil their explicit educational roles, particularly connecting with communication networks such as the growing National Grid for Learning which already includes libraries, colleges and other centres for adult education. As part of the lifelong learning agenda, these providers of informal learning are being encouraged to attract more and different users, targeting 'new audiences' from those who are less accustomed to use them, and signposting other learning directions and opportunities.

The broadcast channels with a public service remit, that is the terrestrial channels of the ITC network, Channel 4 and BBC television as well as radio, demonstrate most vividly the power of a commitment to formal education provision linked to informal learning and the promotion of the whole range of learning opportunities. The high quality of educational as well as educative programmes, both in terms of knowledge content and presentation, has been supplemented by follow-up learning support materials and signposting to other information sources. The success of the BBC's series *Walking with dinosaurs* prompted a surge of visitors to the Natural History Museum and Channel 4's *The 1940s house* caused queues to form for the Imperial War Museum, during the following half-term holidays. However, broadcasting legislation since 1991 has focussed on de-regulation, with pressure to generate commercial income, and is tending to marginalise dedicated educational programmes. There is a trend towards diverting serious educational content from mass to minority viewing channels, pushed out to unsociable time-slots. The BBC is likely to reduce programme-making dedicated to educational purposes and existing programme stock will be concentrated in the new digital channels with a pay-to-view price barrier, requiring either the purchase of a new, highly-priced digitised television-set or the acceptance of a set-top box, cheap or free-of-charge but tied to particular commercial broadcast channels.

The BBC has provided a wide and comprehensive range of non-formal and formal educational programming, as well as informal educative learning opportunities, essentially as distance learning reaching almost all homes, schools and colleges. In addition to through-the-night time slots dedicated to the Open University for mature and second chance learners, and the daytime schools service which includes resources and in-service training for teachers, the BBC established *The Learning Zone* in 1996, to collect together programmes under a range of subjects, and to signpost further learning opportunities. Programmes have treated science seriously, across physics and chemistry as well as life sciences, on topics such as *Seeing with electrons*, *Fluid flow*, *Chemistry and (political) power*, *Enzymes*, *Foretelling fatigue life (of engineering materials)*, *Newton's revolution about science history*. *The Learning Zone* issued subject-based information packs and encouraged adults to follow-up their choice of learning at their local colleges or centres, on a subsidised fee-basis. Learning Link Advisers located regionally, with a brief to connect adult education providers, including colleges, libraries, museums and community centres, to the BBC as a partner concerned to respond to local as well as national demand for learning provision.

Through both television and radio channels, broadcasters have focussed educational content in mainstream programming and many programmes, whether formally or informally educational, have included a trail to other sources of information, knowledge, educational advice and guidance. Broadcasting Support Services have provided back-up materials, in the form of print, video, audio and CD-ROM, and the BBC's on-line learning service has been the most heavily-used education website in Europe.

The BBC's digital Knowledge channel with internet support, dedicated to lifelong learning, was launched in June 1999, but accessible only to subscribers to two of the main commercial cable/satellite broadcasting providers. *Science Fix* offered information about the world and how it works and *Front Room* encouraged users to share their views about programmes, their content and context, through the use of studio discussions, video diaries and webcam links. The Knowledge channel, however, no longer features in the BBC's digital planning. Also, there has been little progress in working jointly with Learndirect to provide mass access to interactive learning programmes so that access to Learndirect remains confined to those 30 per cent or so of homes with their own internet connection.

Broadcasters have supported and on occasions led national campaigns to encourage wider participation in particular forms of learning. Back in the 1980s, the BBC tackled access to IT by manufacturing its own brand-name computer and with government support distributed this free-of-charge to schools. In 1998, for national Adult Learners' Week, the BBC initiated the first Computers Don't Bite campaign, encouraging adults to attend free taster sessions at over 4,000 local colleges and centres, 200,000 people had responded to this initiative by June 1999. A follow-up Webwise campaign was launched in April 1999 to introduce learners to use of the internet, and in January 2001 Becoming Webwise was launched as a structured and accredited course of resource-based units to help people develop their own skills. From autumn 2001, a new on-line support for the development of literacy and numeracy skills will be available to support both learners and tutors.

Many providers of non-formal learning are voluntary organisations, offering participative learning experiences which are based on agreed common interests and concerns with different groups in the community, rather than offering structured but less flexible courses. Many focus on specific cultural subjects, such as Environ, offering short courses on broad environmental and wildlife conservation issues, the Royal Society for the Protection of Birds (RSPB) dedicated to raising public awareness and concern about bird-life, and offering science-based knowledge about species, habitat and the environment, or the National Trust responding to people's interest in heritage conservation, often involving technological knowledge of materials and chemicals, cooking and gardening. Other voluntary organisations target particular groups who suffer social discrimination and/or economic disadvantage, for example Age Concern offering opportunities for older people to learn more about healthy

The NFWI's (National Federation of Women's Institutes) programme 'Linking Science and Everyday Life' was established in about 1994/1995, with funding from the Committee for the Public Understanding of Science (COPUS) together with the Holmes Hines Memorial Trust Fund administered by the Engineering and Physical Sciences Research Council. By 1998, science activities had become so popular that the National Executive set up a Science Committee and a WI Science Network. Activities have included Women's Science Night with a sleepover at the Science Museum, and a National Scientific London visit with opportunities to attend lectures at the Royal Institution. Science-based cascade conferences and residential short courses offered at Denman College have included Explorations from Space, Learn to Surf the Net, Time and Tides and Birds in our World. Members have become involved in national initiatives such as BA's Science Week and Festival of Science activities. In Streamwatch UK, they help to monitor the water quality and presence of organisms in local streams, in a project organised by Manchester Metropolitan University in partnership with United Utilities Community Education, with the involvement of the Wildlife Trust and the Field Studies Council.

The WI has set up Regional Science Co-ordinators who organise Science Clubs and local events including visits to high-tech installations or geological walks, or talks and discussions on topics such as Forensic Science, Chemicals in the Environment, Sounds Mysterious No Longer (on the science of sound), No Elbow Grease but Energy (on the physics of work and energy). The NFWI publishes a *Science network newsletter* every six months and in its annual general meetings has always included formal Resolutions with significant science content, for example on the implications of genetics for agricultural, food and health issues.

living and eating or using IT, the National Federation of Women's Institutes developing provision for their women members, both through local provision for County-based Federations and at their central residential Denman College. Many voluntary organisations also provide formal educational courses, with pre-determined curricula around content, locations and timing related or qualification-bearing courses, or negotiate self-determined learning in the broader adult education tradition. The advantages of this approach were stated to include attracting men into Adult Community Education, which is usually taken up by women predominantly, and in providing opportunities for families to learn together, as well as providing 'women-only' science.

The Workers' Educational Association (WEA) offers open access programmes of non-formal learning, with opportunities for the learners to negotiate their own learning path and pace. For example, WEA Thames and Solent District offers a Women and Science course, based on practical assignments and with maths embedded in experimentation. The first two assignments are based on previous discussion by the learning group on What is Science? and reveals the extent of participants' prior learning, their views on barriers to learning, and encourages them to pose their own expectations of learning outcomes. The course also starts learners thinking about the nature of experimentation and research, as well as revealing personal attitudes to science overall. Initial reactions can vary from familiarity to fear: 'It's complicated, difficult...worrying, dangerous'.

An important aspect of programmes is to develop learners' confidence by doing science. Practical hands-on projects and homework involve learners in planning experimentation, setting up, then collecting and analysing results. As well as introducing broad science concepts in chemistry, physics, life sciences and other knowledge, the course encourages learners to consider ethical aspects of science, how it impacts on people's lives and how it is treated by the media. The District has also offered an Everyday Science course, supported by grants from the BA and the Millennium Fund, and aimed at supporting parents especially in relation to national curriculum Key Stages two and three. The course is 'kitchen sink' style informal learning and aims to encourage adult learners through their commitment to their children's education.

Oxfordshire County Council's Lifelong Learning Service includes provision through several dedicated Adult Education Centres serving different urban and rural populations. Courses in science are responsive to different learners' needs and choices and include:

- BBC's *Star Gazing* and other short courses on Eclipses, Cosmic Discovery and astronomy generally, with tutors from Oxford University Department of External Studies;
- environmental topics in conservation, natural history, geology;
- Finding Out About Science five-week course for people with learning difficulties and disabilities: the first module incorporating work with light, filters, pin-hole camera, etc; a second module on pushing, pulling and forces and a third concerned with the senses of touch, sight and smell;
- Parents in the Classroom by including some science encouraged some parents to go on to the WEAs Women into Science course;
- Everyday Science tutored by the WEA and particularly attractive when free-of-charge for those to whom bursaries could be offered;

- Maths is broadly included in science courses, and Adult Education Centres also run various levels of maths from basic skills through to GCSE and A-levels.

From January to April 2000, the first **Family Science Programme** was offered by a partnership of the Oxfordshire Museum, the River & Rowing Museum, the University of Oxford Botanic Garden, the University Museum of Natural History, Oxford Brookes University and the Northmoor Trust, including a Science Shop for demonstration of experiments and hands-on activities; theatre shows of *The missing link* about evolution and human biology, and *The big drip* about properties of water and other materials; a day of science behind Circus, Stars, Light and Magic; Paper Works and how to make papers from plant fibres; Marble Mazes & Spring daisies, about friction and forces. There is now a regular Family Science programme each term, using a variety of both urban and rural venues for events.

Many Local Education Authorities (LEAs) providing adult and community education see their localised engagement with community interests and family learning groups as particularly rewarding for all concerned, across a wider range of generations than simply parents and children. Local community education providers are in a position to respond particularly positively to learners from black and ethnic minority groups and to support them in ways that are linked to their social needs, are culturally acceptable and recognise their particular curriculum needs and choices. Equally, such localised provision is more able to respond to their local community's health and welfare needs, including working jointly with services who directly support adults with learning difficulties and/or disabilities.

Despite recent increases in funding, there continues to be agreement across all education-providing sectors that insufficient money is spent on developing access for adult learners. The lifelong learning agenda implies that everyone will be encouraged and supported in returning to learning several times throughout their lifetimes, and the Government has committed increased funding in real terms to increase adult and community education provision and educational information, advice and guidance services from 2002/2003 onwards. Yet there is no consistent policy on funding either the desirable mix of provision or increased diversity of learners across all sectors and modes of provision. Broad adult education programmes, whether offered through community-based groups or steered by LEAs through Adult Education centres, Community or Further Education (FE) colleges, continue to operate on a shoestring. Funding methodologies for FE and Higher Education (HE) are still too restrictive to allow for the development of wider access for adult learners, despite funding of pilot projects to encourage non-vocationally oriented provision.

From 1997 to 2001, the DfEE's Adult and Community Learning Fund, promoted through the partnership of NIACE and the Basic Skills Agency, primed many innovative curriculum development projects, targeting difficult-to-reach learners, but it continues to be difficult to embed such work in the mainstream of provision without stabilisation through assured

The University of East Anglia's (UEA's) Centre for Continuing Education set up a Science Starter Programme in 1995, as non-award bearing provision funded by the Higher Education Funding Council for England (HEFCE). The Programme aimed to reach adult learners in rural areas of Norfolk and Suffolk and so was offered at locations in several small market towns. UEA established working relationships with other adult education providers who offered access or pre-access learning opportunities, and who could provide progression routes for those who wanted to go further. This partnership included Norfolk Adult Education Service, University College Suffolk, the WEA's Trailblazer Project, the NFWI, Lowestoft College, West Suffolk College, the Open University and The Castle Museum in Norwich.

Previous work by UEA had demonstrated that there was wide public interest in science, although some diffidence about becoming involved in science education, which seemed to be formal and frightening. Consequently, the Science Starter Programme was well-marketed and publicised, via a regular science programme on BBC local radio, as well as taster experiences on such topics as Dyeing to Find Out, Is Special K Magnetic: Iron in Diet? offered during national Adult Learners' Week, national Science Week, and the County Shows in the summer. For the full programme, a flyer with a pre-paid return slip was distributed via libraries and museums. The first course was offered in three centres as non-accredited pre-access (i.e. below HE CATS level one) six 20-hour short courses and field trips, on topics such as The Art of Scientific Investigation, Energy, Materials, Living Things, Global Issues, and Models (systems for scientific analysis) attracting 23 participants in total.

By 1998, OCN level one and two versions of these courses were established in partnership with Norfolk Adult Education Service. The LEA was unable to recruit viable student groups, partly because it overestimated the market in relation to a multiplicity of centres of provision, and centres were unable to sustain the range of course offers. The OCN-accredited version, however, ran successfully for a year in two market towns. As a further development, a 20-hour course was developed jointly with the John Innes Centre on food and genetics. Entitled You Are What You Eat, it recruited students interested in such topical issues, a market now being catered for with an on-line course on Global Warming .

The Science Starter Programme changed radically in 1999, when HEFCE funding finished. With no funding available for OCN courses run by HE institutions, pre-HE outreach course provision stopped. Instead, UEA developed a series of level one science courses within a 120-credit Certificate of Higher Education in Science, keeping the well-marketed Science Starter name. Students have progressed through this, including two from the original Science Starter Programme. Others have entered degree-level work full-time at UEA or part-time with the Open University.

long-term funding. At about the same time, the Higher Education Funding Council for England's (HEFCE's) funding of Non-Award Bearing Continuing Education projects headlined 'Widening Provision' and 'Liberal Adult Education' promoted interesting development work and local partnerships, but not all of it was sustained and in many instances it was seen to be marginal to the institution's main priorities.

The scarcest resource is usually staff, as well as support for their professional development and training, particularly in the field of broader adult education, where many tutors and other specialists are contracted on a part-time or sessional basis. In museums, for example, while there are dedicated staff teams in the large and national institutions, their time is primarily committed to school parties and the demands of the national curriculum with little margin to devote to attracting new groups of adult learners. In smaller, local and independent museums there will often be only one education officer, sometimes combining this role with other specialist tasks, and with therefore no margin at all to develop more targeted adult learning opportunities.

Despite a continuing commitment by many staff in FE and HE institutions to respond actively and flexibly to individual adult learners and community groups, the complexity and inflexibility of institutional funding reduces the margins for curriculum development, and for trying out new approaches to reach and support adult learners. Targets for student numbers and prescribed outcomes must be met to avoid the risk of losing resources at the next stage. At the same time, funding dictates fee levels which often cannot be afforded by the very learners who are least likely to join in and yet could benefit most.

The allocation of and accounting for resources still tends to channel people into formal courses geared to reaching uniform outcomes across large groups of learners and often those who do not necessarily want to aim for a qualification find themselves directed into

the formality as an administratively cost-effective route. One FE College representative stated,

> 'The biggest discouragement is the need to take the exam and the time needed to succeed. Many adults do not turn up for the exam because they know...they will not do as well as expected, but this is far from failure compared with 16–18-year-olds...Scientists tend not to look at unintended outcomes but only at how much science has been delivered. All too often a lot of science has been delivered but not a lot consumed.'

For both FE and HE institutions, however, the goal of recruiting or achieving students with A-levels or equivalent qualifications in science subjects still seems to be the easiest and therefore most logical entry route, and one that is administratively straightforward in its accounting.

Against this background, however, Adult Education (AE) Centres and FE Colleges not only provide adults with access to GCSEs and A-level studies, but also have also successfully developed an array of Access and Foundation courses, often using these as a springboard to develop more community-based programmes alongside. Although specifically designed to lead people into vocational and qualification-bearing courses in FE and HE, formal Access and Foundation courses have been a significant lever to widening participation in education generally. Over 90 per cent of Access courses are credit-bearing with accreditation through the regionally based Open College Networks (OCNs), which can accommodate partial or interim awards of credit and links to NVQs. The OCN movement is experienced in applying portfolio-based assessment to individual learners' achievements, through Accreditation of Prior Learning (APL) including Experiential Learning (APEL). The OCNs are also ideally placed to take into account work-related or work-based learning, where they can establish equivalencies through the NVQ system. These real learning-based methods are designed to support individual learners who wish to obtain accreditation of their achievements when and how they choose to learn. The OCN movement is by definition a good example of the power of local partnerships of providers to meet local

The University of Sussex Centre for Continuing Education has developed a range of part-time programmes starting with Open Courses in Natural History and Geology, as well as Certificates in Field Biology, Field Geology and Landscape & Locality Studies. Students can take 60 credits from Open into Certificate Courses, and Certificates provide 120 credits at level one, which can be carried forward into the BA degree in Landscape Studies. There is evidence, however, that potential students are inhibited by the emphasis on assessment and the acquisition of credit, especially in relation to maths and science subjects. On the other hand field-based studies encourage them to build up experimental and observational skills over a period of time, especially if there is no pressure to move on to certificate and degree programmes. However, removing the pressure towards linear progression through course levels requires a change in public funding methods for HE provision. Also, course fees are often a problem for learners, particularly when they already have any subject qualification, whether science-based or not, making them ineligible for fee-waivers.

The University of Leeds School of Continuing Education offers an extra-mural programme throughout the West and North Yorkshire plus the Teesside region. Over the last seven years, the School has designed about 140 subject modules specifically for adult learners, accredited at CATS level one or above. These afford the possibility to accumulate credit towards certificates at 60 credits and consequently obtain advance standing in some degree schemes.

About 30 subject modules are offered each year. In addition to generally popular subjects, such as life and earth sciences, experience has shown that courses recruit successfully when they are targeted at specialist interest groups, such as the science and engineering of railway locomotives, or scientific principles underlying the brewing industry, or gold prospecting, for example. Overall, men aged 50+ are more interested in specific aspects of engineering and technology, while women aged 40+ are the main body of the enrolment in life sciences such as botany and botanical illustration. Certificates in ecology or habitat management attract a younger audience. Some courses attract degree course undergraduates, as a choice of elective subjects. All subject modules, however, are developed in the light of the fundamental principles of the chemistry, physics, biology or geology involved.

In a particularly successful development, under the aegis of the University's Office of Part Time Education, the Department of Food Science designed an EU-funded course-package in Food Science, for employees in the food industries. The School of Continuing Education provided teaching in basic chemistry. The course was worth 40 credits in total, of which 30 related to courses common to the first year of undergraduate study. The course package as a whole was intended to provide a qualification in its own right and also potential entry to part-time degree studies. The employers involved were all SMEs, and their feedback demonstrated that the scientific understanding engendered through a combination of theoretical and practical approaches had improved employees' self esteem and confidence, and so their value to the companies involved.

The School of Continuing Education has obtained an EU grant of £226,000 to explore ways of improving provision to disabled students, and intends placing science-related activities including laboratory and field work high on the list of priorities for the project.

The **University of Paisley** in Scotland offers an open-access programme First Steps into Science, Engineering and Technology specially designed for adults returning to learning. This laboratory-based course module, over two semesters of evening attendance, aims to provide learners with an understanding of the diversity and relevance of science and engineering to modern life and to develop their ability to carry out a critical evaluation of science applications through experimental procedures. Learners spend time in chemistry, physics, biology and engineering laboratories, investigating everyday topics and learning

underpinning theory alongside practical work. They gain experience and confidence through experimentation, observation and measurement, interpretation and presentation of results, compilation of supporting information sources and report writing.

The syllabus includes such topics as Grease Busters on synthetic detergents, Physics Fun, The Pendulum: a Wonderful Thing, Numbers Great and Small, The Medicinal Playground, as well as sessions on use of the computer, the library and other study skills. Assessment is continuous and weighted towards practical project work, reporting and oral presentation. Successful completion can gain the award of 15 CATS points at level one.

demand for learning and progression and the over-arching National OCN is now a recognised standards-body for validation of programmes and learner assessment

Unfortunately, there is not yet a fully connected credit accumulation and transfer system to enable people to carry the value of their learning already achieved throughout the education-providing system. While many learners interested in learning for its own sake do not want necessarily to accumulate examination or assessment points, they usually welcome some acknowledgement and record of their individual achievements, and often at a later stage of their own learning plans wish to realise a more formal valuation which can

The University of Cambridge's Board of Continuing Education, based at Madingley Hall, offers a Discover Science programme in over 20 centres covering both urban and rural areas throughout the Eastern region. The programme includes Saturday day-schools on current topics such as Genetic Engineering, our Future or our Failure, Is There Anybody out There? about the search for extra-terrestrial life, or Biodiversity Within a Local Sustainable Society. Weekly courses are held over ten or 20 weeks on everything from practical astronomy and geology, to health-related or environmental topics. Multidisciplinary courses such as The Science Behind the News and Life in the Universe are offered by tutor teams. There are short residential courses at Madingley Hall and Saturday day-schools at local venues of interest, such as geological sites, nature reserves and museums. All ten- and 20-week as well as residential courses carry HE CATS accreditation which can be accumulated towards nationally recognised qualifications. The Board offers a Certificate of Continuing Education for the accumulation of 60 credits at level one and a Certificate of HE at 120 credits at level one, equivalent to the full first year of a degree. Certificates of HE can be structured towards science by specialisation in science core modules in two disciplines such as genetics, geology, astronomy or ecology.

count towards a recognised qualification level. At the same time, according levels of transferable credit is a technically complex subject in its own right, needing in-depth and detailed assessment of what particular bits of learning are worth in relation to each other and ultimately relating to standards of professional practice set by external validating bodies. A further obstacle to progress is the preconceived view of many education providing institutions that learning has to take place within a physical location, supported, monitored and controlled by professional staff. The concept of the learners moving around in time and space according to their own choice is quite alien to this philosophy. As a consequence, the universities' CATS (Credit Accumulation and Transfer) system is geared primarily to enabling mobility between university establishments, and to enabling equivalence to entry qualifications for university courses. Following on from the traditional Extra-Mural approach, however, several University Departments of Continuing Education have been able to use the CATS system creatively to encourage people who embark on open-access study programmes to take their learning further.

The traditional 'Extra-mural' provision, developed in universities over 100 years ago and deemed to be an important part of their role, was marginalised during the 1970s and 1980s. What remains lives on in Departments of Continuing Education which are less well-resourced than the specialist departments of science and engineering subjects in terms of units of funding per student, as well as access to science-based staff and appropriate capital equipment funding. In this context, Adult Continuing Education programmes are usually under pressure within institutions which have other mainstream priorities, so that they have to be defended continually. Specialist space is territorially defended so that it is not readily shared with Continuing Education, but is often only available as an expensive inter-departmental charge. Despite these resource difficulties, many Continuing Education departments have managed to sustain a strong programme of accessible adult education, offering a creative curriculum with opportunities for learners who choose to progress to advanced levels of study in single subject areas.

The Open University (OU) is the world leader in open and distance learning, established over 30 years ago. Since then, more than 2 million people have studied with the OU. It has achieved huge success in transforming peoples' lives by giving them a second chance to learn when they thought that they were limited to the outcomes of their initial education when young. By 2000, the OU had produced about 250,000 Bachelor-degree graduates, about 56,000 of them BScs. One of its greatest achievements, however, has been to demonstrate that basic science is possible at the kitchen-sink, even if nowadays this is limited in scope by health and safety requirements. More importantly, the OU demonstrates that learning about science is not primarily a function of intensive laboratory practice, but more about how people are encouraged to research, analyse observations, cross-reference areas of knowledge and reason for themselves.

The OU operates through more than 300 study centres, distributed across 13 Regional Centres with Advisers for individual advice and guidance. At any one time, there are about 200,000 learners studying towards a degree-level

qualification, and of course many more people will sign up for a single module in their chosen subject, or even just watch the broadcast programmes for interest only. Currently, over 40,000 students are networked for on-line learning and communication with tutors, centres and/or as study groups. Around 20,000 students each year take courses presented by the Science Faculty. Course modules are open-access and can be studied singly or combined to accumulate credits to make up certificates, diplomas, first or postgraduate degrees. Undergraduate courses in science range from ten-point short courses, providing a taster of science learning, to longer courses valued at 30 or 60 points. Progression from introductory levels to specialism is flexible, at the choice and pace of the learner and level one courses are specially designed to help develop or refresh study skills. Through OU Supported Open Learning, every enrolled student is assigned a personal tutor for help and advice while many courses involve face-to-face tutorials and short residential summer schools, for direct teaching to individuals and groups of learners.

Among the OU's examples of good practice in science is The Sciences Good Study Guide to help adult learners to develop their study skills and confidence, particularly about maths. This can be combined with a range of *Breakthrough* study packs which give new learners a flavour of science studies, through such aspects as Thinking about Measurement, Sight and Light, The Material World, or Our living Environment and others. Interactive CD-ROMs supplement home experimentation kits for practical hands-on work. The Discovering Science level one foundation course (S103) is topic-based around earth and life sciences, energy and atomic structure, genetics and evolution. The course structure aims to develop practical experimental and study skills, and via multimedia enables learners to model carbon dioxide in the atmosphere, visualise molecules in 3-D, or take a virtual field trip to the Galapagos Islands. The level two course Science Matters (S280) aims to provide the understanding and skills needed to make informed judgements about major topical issues such as nuclear power, agriculture, genetic engineering and climate change, for example. These courses can lead to a wide range of other modules in biology, chemistry, physics and earth sciences which in turn can be built towards Diplomas or BSc degrees, with Honours. At postgraduate level, the MSc in Science offers opportunities for part-time study in such areas as Public Understanding of Science and Frontiers in Medical Sciences and there are also research-based PhD programmes. The ultimate compliment was paid to the OU's Planetary Science Research Institute's mission to put a British spacecraft Beagle2 on Mars, when two musicians from the pop-group Blur pledged their support saying 'science should be sexy'.

In order to provide better access to learning, providers are encouraged to plan outreach provision, located in communities where people cannot readily attend conventional institutions and their course programmes. This is neither just a marketing device, nor is it solely a geographical distribution mechanism by which colleges and centres additionally

offer their existing programmes and tutors at a range of local centres, or by franchising to other colleges in other places. Outreach provision requires the provider to respond to different communities more flexibly, drawing in those who are socially, economically and/or educationally excluded by identifying with their interests. It offers opportunities for learners to negotiate, plan and manage their own learning activities and aims to empower people as citizens of their own communities. Outreach programmes should not be regarded as short-term projects and cannot be assumed, patronisingly, to be low-level work. It requires wide-ranging responses, and so needs to be designed to be compatible with the institution's mainstream work, with parity of esteem and equality of staff conditions. Educators working through outreach programmes need to design curriculum support to assist learners' development through non-formal as well as formal learning, identifying and providing means by which individuals and groups might make progress. In this sense, learning becomes an essential part of community regeneration, whether in response to social or economic disadvantage, or the isolation of rural or dereliction of urban environments, or the need to research some particular topic of current concern.

Distance learning programmes provide a powerful open-access routes for adult learners, building on their informal and experiential learning and enabling people to tackle their own chosen level of study in their own time, own choice of place and at their own pace. That is not to say that learning is a solitary activity, separate from the influence and exchange of human experience. Quite the reverse: the best distance learning opportunities encourage people to discuss their thought processes, to compare outcomes with others and to learn in ways which share knowledge for wider benefit. For this reason, individual learning via reading, using a variety of distance learning materials including those which are Information and Communication Technology (ICT)-based and interactive, on-line or off-line, is best supplemented by electronic conferencing, bulletin boards, and e-mail discussion groups. Local personal and group tutorials, as well as short residential study schools, provide essential face-to-face contact with tutors and peer learners.

The huge potential of the Internet to deliver on-line teaching and learning materials directly to people in their own homes, both in the UK and internationally, has caused many HE institutions to establish consortia for joint production as a 'virtual university' approach, encouraged by the DfEE. Private and commercial enterprises are also developing distance learning materials, often at low cost to the user. Broadcasters are keen to use the combined power of digitised signal and broadband technology to provide a wider range of channel choice and better quality of transmission of programmes, although not all channels will be free of charge at the point of use. The connection of ICT has the power to extend experience by means of producing a virtual environment for experimentation, observation and analysis by learners, and so is invaluable to science learning, especially opening it up to people in their own locations. Inevitably, however, these new media applications raise questions about the means of quality assurance and accreditation to be applied, and about high costs leading to high charges as a barrier particularly for many of the very new learners we would wish to attract.

Learndirect, established in 1998, is a prime agency in this high-tech world, directed towards the delivery of technology-based on-line and interactive learning to a wider audience. Working in partnerships, on the one hand with local learning centres and on the other with the broadcast industry, it has a remit to signpost existing learning opportunities through educational information, advice and guidance, and also to extend the reach of

distance learning by identifying gaps in provision and brokering the production of new materials to fill them. In October 2000, the e-learning network was launched with almost 500 Learndirect centres based in libraries, community centres and shopping malls as well as colleges, as hubs of communication across the UK, aiming to make available 1,000 course packages by April 2001. A further objective is that by 2003, 1 million people should have participated in some online learning activity. This could provide an ideal vehicle to deliver all levels of science learning, whether informing for general knowledge, for vocational purposes or for continuous professional development. In combination with broadcasters, reaching directly into people's living environments can support those isolated from urban facilities, housebound by disability, or confined for reasons of care or security.

Learndirect's current concentration on work-related learning responds to employers' concerns about skills shortages, voiced during the 1980s and 1990s by the Confederation of British Industry (CBI), and Training and Enterprise Councils. This was endorsed by the TUC and trades unions, bargaining for better education and training opportunities for their members while also extending more widely their own offers of education through models such as Ford's Employee Development and Assistance Programme. The Science, Technology and Mathematics Council (ST+MC) as the National Training Organisation (NTO) for Science and Technology has the unenviable task of charting its way through the balance of skills and training demand and supply. The trades unions, together with ST+MC and others can provide a powerful structure to take forward a wider promotion of science knowledge, ultimately to fulfil the Government's skills-related agenda.

The responsibility to provide sufficient adult learning opportunities generally, and in the sciences particularly, has to lie with Government working with its planning agencies and a broad mix of providers. While FE and HE institutions have the requisite specialist facilities and expertise, they have less knowledge and experience currently about how to target new learners and their communities, as have many of the other resource centres such as museums and libraries. Voluntary sector and traditional Adult and Community Education providers have a strong background of experience and good contact networks in communicating with community groups, but are hard-up in terms of money, space and staff. The argument for partnerships of providers is demonstrable and must be reinforced by the new Learning and Skills Councils, concentrating on local planning and delivery while responding to national development strategies. In that context, providers must not confine their agenda to the narrowly prescribed offers of previous years, but work to achieve a wider vision of lifelong learning for all, including access to science for everyone.

The trouble is, science sounds seriously scary. From our early learning, we are told that it is difficult, only open to those who can do the maths and pass the exams, so it's hardly surprising that large numbers of new learners have not rushed to join in. Yet, for some time there has been considerable promotion of the value of science and engineering studies, by the British Association for the Advancement of Science (BA), the Committee for the Public Understanding of Science (COPUS), the Royal Institution and other professional institutions, as well as interested colleges and universities themselves. So we need to examine why the message may not be reaching those whom we most want to convince, perhaps owing to factors which include:

- ☐ not responding to people's interests and concerns but talking at them in the wrong language;
- ☐ talking mainly to those already motivated and committed to science learning, rather than the unconvinced;
- ☐ lacking a coherent and concerted plan to campaign for wider participation in science.

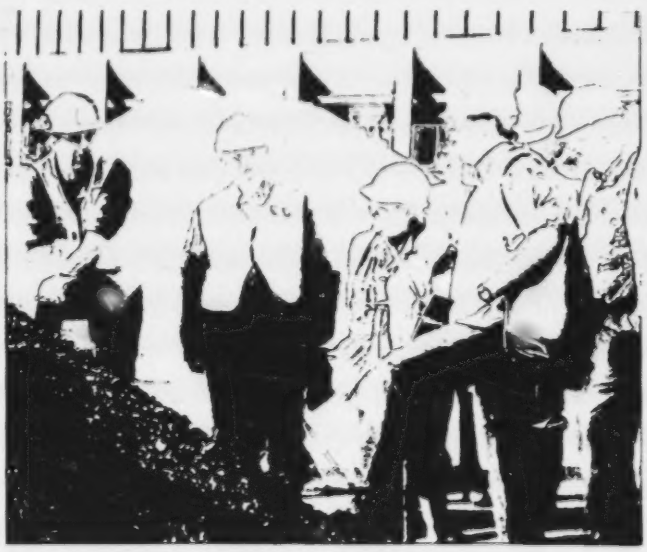
Although the science research community defends and seeks to sustain the ethos of sharing and disseminating experimental knowledge widely, through long-established and well-used

specialist journals and electronic communications networks such as Higher Education (HE's) Janet and Superjanet, scientists are less practised in explaining and sharing their discoveries with a wider public. Like all professionals, scientists have developed their own specialist language for rapid and efficient communication among themselves, but this jargon excludes most people.

Those who are convinced about the value of science and knowledgeable about its content have a heavy responsibility to inform and educate the public through a variety of media. Of course, it must be acknowledged that not all scientists can be transformed into gifted communicators, but those with talent should be fostered in this, as with any other skills area. Scientists who are trained to observe, report on and debate experimental research in a rigorously factual way also need training in creative modes of presentation, in ways of relating to the media and in the importance of being willing to engage with journalism. They also need to be aware of the risks associated with mis-reporting and of the means available to redress serious transgressions in this context. Already, the Royal Institution, with the BA and COPUS, offers programmes of media training and Media Fellowships for scientists to encourage presentation of information in ways which facilitate accurate and responsible reporting. Wider promotion of these opportunities, building them into existing science programmes and extending localised access to specially designed short courses, would increase the awareness of more scientists to the importance of this issue.

As shown by earlier attitude surveys among the public in general, most people say that after school, their biggest sources of science information are television, newspapers or magazines. Yet the MORI survey carried out in 2000 for the Wellcome Trust, about scientists' views on their role in presenting information to the public, showed that most of them have never had any specific training in dealing with the media. It also showed that although most believed that the public obtained its information mainly from the press and television, and that journalists were not particularly well informed about science topics, many scientists would still rather talk to their peer group of scientists. Another MORI survey for the Better Regulation Task Force in 1999 showed the highest level of trust in doctors (89 per cent) followed by teachers (88 per cent) and then television news readers (75 per cent) to tell the truth, but much less confidence in government scientists, deemed more likely not to tell the truth, (46 per cent) and even more so Government Ministers (71 per cent) and journalists (82 per cent).

These differences in public perceptions have some real foundation. Radio and television broadcasters continue to be influenced by the Reithian tradition of informing and educating as well as entertaining. Frequently, they follow up specialist programmes with promotion of new learning opportunities, whether through published support materials, or dedicated educational programming. Reaching into 99 per cent of homes and accessible through schools, colleges and commercial organisations, their structured support for the national



Science on the Underground was the bright idea of Brenda Keogh and Stuart Naylor, who lecture in science education at Manchester Metropolitan University's School of Education. They both have extensive experience of working with teachers to promote effective teaching strategies. They have also published in this field, and although mainly geared to school teaching, the underlying principles of their *Starting Points for Science* are applicable to adults' learning also, in relation to encouraging active hands-on engagement with science activities relevant to learners' interests. In 1998, they developed an action research project, designing concept cartoons about science in order to attract public attention and motivate people to follow up their curiosity. The project was given advance publicity in the national press between November 1997 and March 1998, as well as on television and radio during March.

From 2 March to 6 April four different posters were displayed on the London Underground, posing questions such as 'What happens when you take the lid off a bottle of fizzy lemonade – does it lose or gain weight, or stay the same?'. The posters did not carry the answers but encouraged people to check with the Science on the Underground website, by telephoning the Science Line as a general science information service, or by visiting the London Transport Museum. The project, funded by COPUS, the BA, Glaxo Wellcome, the Institute of Physics and others involved, aimed to:

- put science in a venue where it was unlikely to be ignored;
- make thinking about science part of the everyday experience of Underground travelers;
- make science accessible to the public through the use of a visual format;
- stimulate follow-up activity through the use of sources of information;
- create new opportunities for the use of concept cartoons to promote public understanding of science.

From an independent evaluation exercise (by a sample of observations and interviews carried out in April 1998), the main findings included:

- there was a high public awareness and interest in the posters, irrespective of age, gender or scientific background;
- the use of cartoons and clear language to describe scientific principles was successful in appealing to a broad range of people without condescension;
- the posters were seen to be successful in getting people to think about science, whether just to relieve the boredom of travel, or as a way of de-mystifying science;
- parents and teachers particularly saw the posters as a valuable motivator;
- the poster stimulated follow-up action, with about 15,000 hits on the Science on the Underground website plus an extensive list of mostly positive comments – there were relatively few calls to the Science Line, however;
- the project was even discussed on Clive James' TV chat-show!

Subsequently, the posters have appeared in Stockport County's football programmes and have been requested for use in teaching environments, for example in interactive science centres and by the National Federation of Women's Institutes (NFWI's) Regional Science Co-ordinators. The posters have also been displayed on transport systems in several cities in Sweden and Russia. Following Science on the Underground, a similar idea has been developed through the Science on the Buses Project, involving the Royal Society of Chemistry (RSC), with the School of Interdisciplinary Sciences at the University of West of England in Bristol, the British Council, Unilever plc and others, with promotional posters designed by Graphic Science appearing on buses in Birmingham, Manchester, Cambridge, Edinburgh and Belfast.

promotion of literacy, health-related education, and other topics is crucial. Broadcasters have encouraged vast numbers of new learners through actively supporting broad campaigns such as those promoting information technology (IT) skills, national Adult Learners' Week and others. The use of high-audience 'soaps' like Channel 4's *Brookside* and media celebrities like the botanist David Bellamy effectively convey social and educational messages, and there have been television adverts, featuring pop-star Billie Piper and comedian Richard Blackwood, promoting science creatively. Many viewers still remember the stunning impact of James Burke's television series *Connections* in the 1970s, and many would like to bring it back as one of the most effective means of exciting non-scientists about science.

Broadcasters are accustomed to fill substantial timeslots through in-depth reporting, and for pre-scheduled programmes there is a volume of background research as part of the production process. While conscious attention is paid to audience rating figures, and there is competition between different channels, with tension between the demands of public service and commercial advertising, the saturation of broadcast receivers gives broadcasters a stronger platform of programme planning. The reach and influence of both national and local television and radio makes broadcasting an essential medium, whether for a concerted promotional campaign about science learning generally, for specific subjects, or as a partner for promotion of local provision.

Equally, the specialist journals such as *New Scientist, Nature, Scientific American* and others, have a serious and explicit mission to extend knowledge of science and awareness of its new developments to a wider audience, which includes the lay public as well as science specialists. Some newspapers treat science and technology seriously and responsibly, with specialist journalists, dedicated pages, or weekly supplements, such as the *Guardian*'s 'On-line' backed up by its Website learn.co.uk which offers on-line learning materials and includes national curriculum science topics, as well as the new EducationGuardian.co.uk providing news, information and support for teachers and students in all sectors of education.

By contrast, the circulation war among newspaper publishers encourages sensationalism of headlines to capture a bigger share of the reading audience who have to be tempted to buy

daily. There is a marked difference of approach when a subject is sufficiently newsworthy to hit the front page headlines, and is written up to a tight deadline by a general journalist with a 'star' byline but with less knowledge of or interest in the science content. Emotive subjects such as live animal research versus the animal rights movement are a case in point, when the confrontational claims and behaviour of opposing factions are the news item, with less inclination to explain in depth the aims and techniques of the research, the requirements of legislation, and the potential to effect change to accommodate new ways of thinking and working.

NIACE promotes adult learning opportunities nationally and regionally through Adult Learners' Week in May each year and Sign Up Now campaigns in time for enrolments in September and January. The BA similarly promotes science and technology through National Science Week in March and an annual Festival of Science each September. As part of national SET (Science, Engineering and Technology) Weeks held annually and involving several of the promotional and professional and associations, the RSC celebrates Chemistry Week every second year, with the next event to be held in November 2001. In recent years, the BBC in association with the Department for Education and Employment (DfEE now the DfES) has held a major exhibition event Tomorrow's World Live at Earls Court, featuring star presenters and lots of whizz-bang demonstrations, although it seems to have been aimed mainly at the entertainment of schoolchildren rather than adults. These events attract considerable publicity in both the national and the local press, and through the use of directly targeted information.

In 2000, the Government supported Maths Year, following this up by a 'Count On' project to encourage better numeracy skills. From September 2001, the DfES will fund Science Year, appointing NESTA (the National Endowment for Science, Technology and the Arts) to deliver a high profile campaign to 'transform attitudes towards science and technology'. Sadly, despite objectives which include raising public awareness and understanding of science, promoting the idea that science is fun and relevant to everyday life, increasing the take-up of science in further study, celebrating achievements in science and identifying role models especially for girls and people from black and ethnic minority communities, Science Year activities are aimed mainly at young people aged 10–19. There is little reference to the Department's own policies around lifelong learning or to adult learning opportunities wider than vocational Further Education (FE) and HE, and yet Science Year offers an opportunity which should not be missed to bring science to the forefront of everyone's mind, children and adults alike.

Worthy though these different promotional and publicity-generating activities are, there is little connection among them. There needs to be a more concerted approach to a broad front campaign, in order to establish a common agenda for wider participation in science education and to celebrate both examples of good practice by creative practitioners as well as outstanding achievements by adult learners. More than anything else, however, the adult public's right to know more about science and technology needs to be recognised in a really useful way, as that is the all-encompassing purpose of education in science.

Within the current lifelong learning agenda there is a prime opportunity to develop better access to learning about science and technology, as a means of enabling the public's entitlement to knowledge and understanding. Participation can be widened beyond the narrow band of specialists, for professional practice. There are already many examples of good, innovative adult learning practice, even if disconnected and on a relatively small scale of student numbers. These examples need to be promoted and publicised more widely, celebrating their achievements. Information and Communications Technologies (ICT) open up new ways to deliver directly to many more new learners, provided they can afford the hardware and software or achieve access though publicly available facilities in libraries and ICT Learning Centres. However, to support so many good initiatives and opportunities for expansion, of both teaching and learning practice and in the promotion of science learning, more substantial and sustained financial resources need to be committed to reaching those who have not benefited previously.

Above all, a more concerted and coherent voice is needed to argue the case for adult learners' access to science and technology knowledge, with the commitment of agencies which have the power and the resources to deliver a wider range of provision. As one of the respondents to NIACE's questionnaire said, 'Let's make it less stuffy!'.

The following recommendations are offered, to target possible ways to change for the better.

For NIACE:

- ☐ to support a broad front campaign for wider participation of adult learners in science learning;
- ☐ to persuade broadcasters to programme a science season each year, working with adult education providers in all sectors to signpost a broader range of learning opportunities;
- ☐ to work with the British Association for the Advancement of Science (BA), the Committee for the Public Understanding of Science (COPUS) and other interested agencies to highlight the value of adults learning science, through the annual Festival of Science and National Science Week;

- ☐ to collect and publish case studies and methods of good practice for adult teaching and learning in science;
- ☐ to feature good practice and successful adult learners in science within Adult Learners' Week and Sign Up Now campaigns;
- ☐ to include access to science in one major conference each year on relevant policy and practice, and contribute to other organisations' conferences and seminars.

For BA, COPUS, and professional institutions in science and technology:

- ☐ to continue to heighten public awareness and provide information about science-based topics;
- ☐ to spearhead a broad front campaign, working with NIACE and other agencies to promote and develop more and better learning opportunities for adults in science;
- ☐ to continue to support scientists to develop better means of communication with the public, especially through media training which includes the press and broadcasters;
- ☐ to work jointly with a wider range of adult education providers, highlighting good practice and promoting learning opportunities in and through science;
- ☐ to support the provision of discussion forums, events and activities in non-traditional venues, especially during National Science Week and the Annual Festival of Science.

For broadcasters:

- ☐ to support and promote a broad front campaign promoting wider participation by adult learners in science;
- ☐ to continue to develop provision of science learning opportunities, both formal and informal, through dedicated programming;
- ☐ to promote mainstream programme seasons and series highlighting science learning;
- ☐ to feature local activities and learning opportunities during BA's Science Week and the Festival of Science.

For Open University and Learndirect:

- ☐ to encourage a wider range of providers to adopt effective means of delivering open and distance learning programmes in science, suitable for adult learners at all levels;
- ☐ to ensure that Learndirect educational information, advice and guidance services provide a comprehensive support to potential adult learners in science.

For Further Education (FE), Higher Education (HE) and Adult Education (AE) providers, including trades unions, museums, libraries and other non-formal agencies:

- ☐ to form local consortia in planning and providing a comprehensive range of lifelong learning programmes in science, with more and better opportunities for wider participation;

- ☐ to work jointly in the marketing, promotion and publicity of programmes, targeting new learners who have not previously benefited;
- ☐ to consult community groups in relation to their interests and concerns around science-based topics;
- ☐ to provide access at all levels of science knowledge and learning, from basic skills of science literacy and numeracy to advanced level programmes;
- ☐ to develop outreach opportunities, with non-formal learning in accessible locations;
- ☐ to work jointly to develop flexible and connected accreditation frameworks for learners' progression.

For Learning and Skills Councils, Local Learning Partnerships. Local Education Authorities and Regional Development Agencies:

- ☐ to review local access to science-based learning;
- ☐ to integrate learning opportunities in science and technology in community development planning;
- ☐ to encourage local consortia in planning, developing and providing science learning programmes;
- ☐ to encourage the development of pathways for learners to progress through different modes and levels of science learning;
- ☐ to monitor both nationally and locally the range and number of science learning programmes made available;
- ☐ to support the development and dissemination of good practice, encouraging the promotion of learning opportunities in science.

For DfES, other Government Departments and agencies:

- ☐ to follow up Science Year by supporting a broad front campaign to widen participation of adult learners in science;
- ☐ to initiate a broad-based cross-departmental programme to encourage all means of adults engaging with science;
- ☐ to develop a measurable national learning target for widening adult participation in all forms of learning, including in science subjects;
- ☐ to review institutional funding mechanisms in order to provide more flexibility in valuing broader adult learning programmes intended to encourage wider participation in non-qualification bearing science subjects;
- ☐ to offer Individual Learning Accounts for learners entering short, part-time non-qualification bearing science programmes;
- ☐ to encourage and support partnerships of agencies working to promote and develop science learning opportunities;
- ☐ to support the Teacher Training Agency and providers of FE and HE in reviewing and developing means of increasing the supply of science-based teachers;

- to support the General Teaching Council and adult education providers in all sectors to develop better science resources for teachers, with opportunities to share practice and experience;
- to increase resources for and access to staff development for teachers, as INSET and continuing professional development activities to support all levels of science learning provision.

APPENDIX 1

National Institute of Adult Continuing Education (England and Wales)

Advisory group on adult learners and science: core membership

Richard Ely	NIACE Honorary Treasurer (Chair)
Shiela Carlton	Honorary Life Member and Consultant, NIACE
Sasha Anderson	Research Assistant, NIACE
Jane Thompson	Development Officer, NIACE
Rob Chapman	School of Continuing Education, University of Leeds
Ann Lancett	PR Manager / Chemistry Lecturer, Coleg Glan Hafren
Andrew Morris	Research & Development Manager, Further Education Development Association
Tricia Rees	National Federation of Women's Institutes Education and Training Network
Pearl Ryall	Curriculum Manager, Workers' Educational Association Thames and Solent
Barbara Smail	North West Regional Coordinator, British Association for the Advancement of Science
Agnes Segal	Institution of Electrical Engineers
Jeff Thomas	Head of Centre for Science Education, Open University
Alan Timms	Head of Adult Education, Natural History Museum

Many thanks are due to the members of the Advisory group who were unstinting in their helpfulness, patience and advice throughout. Similarly, thanks are due to NIACE Executive Committee and other members, to all my colleagues on NIACE staff and also to the wide range of other correspondents listed in Appendix 2.

APPENDIX 2

Respondents to NIACE survey

During the period July – September 2000, the following responded to a brief survey questionnaire to collect views about adults' participation in learning opportunities in science subjects:

Basildon College
Beverley College
British Association for the Advancement of Science
Bromley Adult Education
Burton College
Coleg Glan Hafren
Coleg Glan Hafren Learners' Focus Group
Coventry University, Centre for Science and Engineering Education
Drom e Ty Avow, Wrexham
East Luton Community College
Engineering and Physical Sciences Research Council

Further Education Funding Council, Science Inspectorate (until April 2001)
Further Education Development Agency (since April 2001, Learning and Skills DA)
Institution of Electrical Engineers
Milton Keynes Adult Education
National Federation of Women's Institutes
Natural History Museum
North Tyneside Community Services
Open University in Wales
Oxfordshire County Council Lifelong Learning
Peterborough Regional College
Preston College
Royal Society of Chemistry
St Helens College
Sheffield College
Southend Adult Community College
Thomas Danby College
University of Cambridge, Board of Continuing Education
University of Leeds, School of Continuing Education
University of Oxford, Department of Continuing Education
University of Paisley, Centre for Continuing Education
University of Manchester, Centre for Continuing Education
University of Stirling, Institute of Education
University of Sussex, Centre for Continuing Education
University of West of England
West Berkshire Education Department
Workers Educational Association, Thames and Solent District

Other respondents who have been helpful in the course of the work are:

Jean Barr, Head of Department of Adult and Continuing Education, University of Glasgow
Professor Di Bentley, Director School of Education, Sheffield Hallam University
Peter Briggs, Chief Executive, British Association for the Advancement of Science
Anita Edwards and Kate Ward, Women's Science Forum, Women's National Commission
Brenda Keogh and Stuart Naylor, Manchester Metropolitan University
John Nicholson, Science Starter Programme, University of East Anglia
Daniel Sandford-Smith, Association for Science Education
David Ward, Lifelong Learning Development Officer, City of Salford Education and Leisure
Valerie Ellis, Assistant General Secretary, Institution of Professionals, Managers and Specialists

APPENDIX 3

Statistics

1. In Britain:

- about 7m adults have serious difficulties with literacy and numeracy, i.e. about 20 per cent of the population over 18 years of age (Source: Moser C. [1999] A Fresh Start, Improving Literacy and Numeracy, HMSO);

- about 5.7m adults of working age have no qualifications at all, i.e. about 20 per cent of the population aged 17–65;
- in 10 per cent of the most deprived wards, 30 per cent of the adult population have no qualifications, while in 10 per cent of the least deprived wards, only 8 per cent have none (Source: DETR Index of Deprivation);
- in 1978, about 12 per cent of 18–19-year-olds entered Higher Education and by 2000 this had increased to about 32 per cent;
- currently, there are about 2.5m learners enrolled on FE courses, of whom 73 per cent are over the age of 19; of these, 90 per cent are studying part-time;
- by 2010, the Government's target for participation in HE is 50 per cent of 17–30-year-olds (in Scotland, this has already been achieved with about 58 per cent participation, but already there is evidence of a turn-down in participation in England and Wales).

2. Demographics illustrate that adult learners are more important then ever before. With increasing affluence, falling birth rates and better health care extending longevity, our society will become older over the next 25 years or so, with more elder women than men. It has been predicted that by 2025, the proportion of the UK population over 60 years of age will increase to 26.8 per cent (Source: G.Dooghe [1992] *The ageing of the population in Europe: socio-economic characteristics of the elderly population*, EC Brussels). Already there is concern that fewer young people will enter paid work and be able to support their elders. Equally, many older people chafe at the confine of a set retirement age at 65 and increasingly want or need to continue or change working roles. Many women, older and younger, need to ensure their economic independence and to be able to support their children single-handedly, whether as a consequence of bereavement, divorce or choosing to stay single. There is increasing emphasis on the goal of maximising independent living for people with learning difficulties or disabilities. Much of our community development and welfare depends on active volunteering with training to enhance this. For all aspects of change, access to learning opportunities is essential for everyone throughout their lives, whether for work, personal development, or for interest and fun.

3. Over the last ten years, NIACE (the National Institute of Adult Continuing Education) has conducted three surveys of adults' participation in the whole range of learning opportunities, both formal and informal. Comparing the 1996 survey with the most recent survey carried out in 1999 (published as *The Learning Divide Revisited*) showed an element of stability with little overall change, apart from some interesting specific points of variation. The latest survey was conducted over a sample of 5054 adults aged 17 and over, across the whole UK, during a period of 18 days.
4. The good news was that there was general support for the concept of lifeiong learning as 94 per cent believed that learning is something people do throughout their lives, and 72 per cent were confident about learning new skills. While there was still a strong vocational rationale for returning to learn, with 66 per cent of all of the sample from age 17 through to their mid-50s saying they were aiming for a qualification, fewer at 11 per cent said they chose their subjects in order to get a recognised qualification or to go on another course in future. The bad news was that science and engineering subjects did not figure highly, with only 4 per cent in engineering and 5 per cent in pure science/maths/statistics.

Within these overall proportions there was an age-skew as in pure science/ maths/statistics about 13 per cent were under 20, while participation dropped to 2–4 per cent amongst the over 25s. Computer studies continued to be popular, at 25 per cent of all adult learners, the major proportion of them amongst older learners from age 45 through to 74, compared to only half this participation rate amongst younger learners under 25.

5. Other main findings were:

   - 22 per cent of all ages were currently learning about something, 24 per cent of the men and 21 per cent of the women;
   - 40 per cent of all were either currently learning or had learned recently, within the last three years, and the gender divide was fairly close with 41 per cent men and 40 per cent women – but of course, this means that about 60 per cent overall had not done any learning recently;
   - previous educational experience and length of initial education had significant bearing on adults returning to learn: of those who left school at age 16, 25 per cent were currently or recently learning, with 50 per cent of those who continued through age 18, rising to 61 per cent of those who kept going beyond 20 years of age;
   - overall, 37 per cent said they had done no further learning since completing their initial full-time education, skewed by gender as 40 per cent of women had not done so compared with 34 per cent of men – significantly, 13 per cent of all women cited childcare or care for other dependants as the barrier to joining in, rising to 20 per cent for those with children aged 5–15 and 37 per cent for those with children under 5;
   - social class continues to skew participation rates, as 58 per cent of ABs said they were currently or recently learning, with only 16 per cent registering none since leaving full-time education, 51 per cent of C1s continuing compared to 25 per cent not, and only 24 per cent of DEs currently or recently learning compared to 57 per cent not.

6. Employment status was a critical factor in determining people's participation in learning. For many, the workplace provides resources and opportunities to learn, or to access learning externally, supported by their employer. 51 per cent of full-time and 50 per cent of part-time workers are current or recent learners, and the latter category shows a distinct improvement from previous surveys. 27 per cent of full-time and 10 per cent of part-time workers get support from their employer for external course fees, while 14 per cent of full-time and 7 per cent part-time workers have access to direct employer-funded provision. Again, however, men fare better than women, with 19 per cent of men compared to only 13 per cent of women having their fees paid by their employer. From the survey in 1996, compared to 1999, there was a decrease in participation amongst those who were 'retired' although this state is more difficult to define as attitudes to employment change. Many 'retire early' but still engage in paid or unpaid work, while the term 'unemployed' only measures those registered with Job Centres to receive benefit as actively looking for paid work.

7. In relation to age, participation of 17–19-year-olds in current or recent learning had dropped from 86 per cent in 1996 to 81 per cent in 1999, perhaps reflecting better

immediate employment prospects for younger people. For other age ranges, however, there was an increase in participation rate, from 65 per cent to 70 per cent for ages 20–24 up to an increase from 25 to 30 per cent at ages 55–64, until a downturn at ages 65–74 decreasing from 19 per cent to 16 per cent and at age 75+ from 18 per cent to 9 per cent. So our elders do not get much opportunity to join in.

8. The location of learning says much about where provision is predominantly available, with 20 per cent learning in FE colleges, 18 per cent in a university, 18 per cent in the workplace, 10 per cent learning informally, usually at home, and 8 per cent learning in an AE centre or at 'evening classes'. Clearly there is a variation in relation to age, with school, college or university being more for the under 25s, workplace for the middle band of ages 25–64, and AE or informal learning being more for the older age groups from 45 onwards. There is also a pronounced gender difference with 21 per cent of men learning at work compared to 15 per cent of women, while this reverses in FE with 17 per cent of men compared to 23 per cent women, and 6 per cent men and 10 per cent women in AE.

9. Sources of educational information, advice and guidance varied significantly with age. Nearly 70 per cent of younger people aged 17–24 inevitably obtained most of their advice through school or college. From ages 25–64, for more than 30 per cent most information was gained through the workplace or from workmates with some gleaned from colleges or family and friends. For older learners, informal sources were more important, with family and friends the best source, followed by newspaper adverts, then Adult Education Services directly, followed by direct mailing of leaflets to homes or via public libraries. Overall, only 1 per cent mentioned the internet and 1 per cent, telephone helplines, perhaps reflecting the lower public awareness of and access to technological sources. However, it is important to remember that even 1 per cent, when extended to the total adult population, represents over 250,000 people and that the Learndirect telephone helpline, for example, has responded to 2.5m calls over the last 2–3 years.

10. There is less access to new technologies than the media would like, and it is heavily weighted towards the AB and C1 socio-economic groups, to younger people, and to those with access at their workplace or in an educational or other institution. Consequently, gender difference applies again with more men than women having access to a PC. The proportion of home-based PCs is now approaching 40 per cent, but only 25 per cent of homes have an Internet connection, so that there is a long way to go before computing technology can deliver educational information, advice and guidance, as well as knowledge-based materials, to everyone.

11. Finally, NIACE's latest survey report *The Learning Divide Revisited* opened by setting a context for the research work, saying 'Lifelong learning is not a new sector of education and training to be fought for in competition with other sectors. It is, quite simply, the expectation that people will be able to choose to come in and out of different learning opportunities throughout their lives and that educational providers at all levels will expect to meet the varied needs of adults, of all ages... It is the expectation that learning will become the norm among adults, that is the key to change.'.

APPENDIX 4

Bibliography

ACACE (1981) *Basic science education for adults, report of the Advisory Council for Adult and Continuing Education*, ACACE

Barr J. (1999) *Liberating knowledge: research, feminism and adult education*, NIACE

Barr J. and Birke L. (1998) *Common science: women, science and knowledge*, Indiana University Press

Bates K. (Ed), (2001) *University of the 3rd Age Science and Technology Network Newsletter 4.*

Bentley D., West R., Wilson C. (1996) *Open science: lifelong learning through science*, report by the Post-16 Science Study Group, Association for Science Education

Bodmer, W. (1986) *The public understanding of science*, Birkbeck College
17th J.D.Bernal lecture

'British Council Science Education Newsletter' (2000) NESTA Education Programme, 147, 3 January

Byers S. (2001) *Science people can trust*, DTI, March
speech to the British Association Science Forum, http://www.dti.gov.uk/ministers/speeches

Carlton S. and Soulsby J. (1999) *Learning to grow older and bolder*, NIACE

Carrington B. and Bonnett A., et al (2001) *Ethnicity and the professional socialisation of teachers: report to the Teacher Training Agency*, Universities of Loughborough, Newcastle and Hertfordshire, March

Coffield F. (1999) *Breaking the consensus: lifelong learning as social control*, Inaugural Lecture as Professor of Education, University of Newcastle, February

COPUS (1998) *Out and about, organising public events: a collection of case studies from the COPUS grants scheme, Committee on the Public Understanding of Science*, Sharing Best Practice Series, COPUS

Cresson E. (1995) *Towards a learning society: teaching and learning for the 21st century*, European Commission

Dawkins B. (Ed) (1995) *Analysis of essays*, WISE 10th Anniversary essay competition, Women Into Science and Engineering

De Lors J. (1993) *Growth, competitiveness and employment*, European Commission White Paper

DfEE (1998) *The learning age: a renaissance for a new Britain*, Command 3790, DfEE

DfEE (1999) *Individual learning accounts: a summary of progress*, DfEE

DfEE (1999) *Learning to succeed: a new framework for post-16 learning*, Command 4392, DfEE

DTI (1993) *Realising our potential: a strategy for science, engineering and technology*, Cmnd 2250, HMSO

DTI (1997) *Breaking the mould: an assessment of successful strategies for attracting girls into science, engineering and technology*, DTI

DTI (2000) *Excellence and opportunity: a science and innovation policy for the 21st century*, Cmnd 4814, DTI

Ede S. (2000) *Strange and charmed: science and contemporary visual arts*, Calouste Gulbenkian Foundation

Fryer R. (Chair) (1997) *Learning for the 21st century, first report of the National Advisory Group for Continuing Education and Lifelong Learning*, HMSO

Fryer R. (Chair) (1999) *Creating learning cultures: next step in achieving the learning age, second report of the National Advisory Group for Continuing Education and Lifelong Learning*, HMSO

Fuller P. (2000) 'Sci-journal', British Council Science Education Newsletter, 150, 10, July

Hargreaves I. (2000) 'Is that Frank — or Frankenstein?', *Guardian Education*, 19 September, 14-15

Hargreaves I. (2000) *Who's misunderstanding whom: science, society and the media*, ESRC
www.esrc.ac.uk

Harris J. (1998) *Science on the underground: an evaluation*, EducationExtra, May

Harris S. (2000) 'Science and society project', *RSA Journal*, 2, 35

Hawkey R. (2001) 'Innovation, inspiration, interpretation: museums, science and learning', *Ways of knowing journal*, 1 (1), 23-31

Inman J. and Wilson C. (1998) *Second time around: confidence in adult returners to science education*, University of Durham
www.chem.vt.edn/confchem/1998.Wesson.2ndtim.htm

Irwin A. (1995) *Citizen science*, Routledge

Kennedy H. (Chair) (1997) *Learning works: widening participation in further education*, FEFC
Chair Further Education Funding Council's Widening Participation Committee

Keogh B. and Naylor S. (1996) *Starting points in science*, Millgate House Publishers

McGivney V. (2000) *Recovering outreach: concepts, issues and practices*, NIACE

Millar R. (1996) 'Towards a science curriculum for public understanding', *School Science Review*, 77, 280, 7–18

Millar R. (2000) *Science for public understanding: developing a new course for 16–18-year-old students*, Department of Educational Studies, University of York

Millar R. and Osborne J. (Eds) (1998) *Beyond 2000: science education for the future*, Report of seminar series supported by the Nuffield Foundation

MORI (1999–2000) *The role of scientists in public debate: research study*, Wellcome Trust, December–March

Morris A. (Ed) (2000) *Revitalising physics education*, Shaping the future series (Campbell P. – series Ed), Institute of Physics *Post-16 Initiative*

Moser C. (Chair) (1999) *A fresh start: improving literacy and numeracy*, report of the working group on post-school basic skills, HMSO

Preece J. (ed) (1998) *Beyond the boundaries: exploring the potential of widening provision in higher education*, NIACE

Sargant N. (2000) *The learning divide revisited: a report on the findings of a UK-wide survey on adult participation in education and learning*. NIACE

Smithers A. and Robinson P. (1994) *The impact of double science*, The Engineering Council

Stationery Office (1998) *Bringing Britain together: a national strategy for neighbourhood renewal*, Cmnd 4045, Stationery Office

Stationery Office (2000) *Science and society, House of Lords Select Committee on Science and Technology*, HL Paper 39, Stationery Office

The Dish (2001) Working Dog Productions
Fantastic and funny film about radio telescope scientists in Australia tracking the 1969 Apollo 11 landing on the moon

TUC (1995) *Bargaining for skills: trade unions and training and enterprise councils working in partnership for training*, TUC

Tudge C. (2001) 'Why science should warm our hearts', *New Statesman*, 26 February, 25-27

UNESCO (1996) *World science report 1996*, UNESCO

Wanless D. (Chair) (2000) *Aiming higher*, NACETT report on the national learning targets for England for 2002 and beyond, NACETT

West R. (1996) *Open science: lifelong learning through science conference April 1996*, Association of Science Education

Wynne B. (2000) 'Retrieving a human agenda for science', *RSA Journal*, 2,4-6

LIFE, THE UNIVERSE AND ALMOST EVERYTHING

The Value of Adults Learning in Science

A Policy Discussion Paper

Knowledge of science and technology is important to enable everyone to understand and participate in critical debates for our future. Education is the key, but the developing agenda of lifelong learning does not connect well with science programmes, particularly for adult learners.

This paper aims to contribute to the debate by connecting three powerful and current issues:

- Citizens' right to know more about science and technology and the responsibilities of scientists and the media to inform.
- Widening access to science knowledge for all, by encouraging more and different forms of provision, beyond the narrow focus of vocational and professional qualification programmes.
- Providing real lifelong learning opportunities to satisfy personal interests, the excitement of discovery and for fun.

The paper advocates means of widening participation and sets out a range of examples of good practice. Varying participation by different target groups of learners is discussed as an aspect of social exclusion. Recommendations are made for different agencies, including national and local government, professional institutions, education providers, broadcasters and the media.

NIACE
21 De Montfort Street
Leicester
LE1 7GE
Tel: 0116 255 1452
Fax: 0116 285 4514

NIACE is a company limited by guarantee and a registered charity
Company registration no. 2603322
Charity registration no. 1002775

NIACE
THE NATIONAL COUNCIL FOR ADULT EDUCATION

ISBN 1-86201-127-3
9 781862 011274

CE 063 832

U.S. Department of Education
Office of Educational Research and Improvement (OERI)
National Library of Education (NLE)
Educational Resources Information Center (ERIC)

REPRODUCTION RELEASE

(Specific Document)

I. DOCUMENT IDENTIFICATION:

Title: Life, the Universe and Almost Everything: The Value of Adults Learning in Science	
Author(s): Sheila Carlton	
Corporate Source: ~~29~~ NIACE	Publication Date: Sept 01.

II. REPRODUCTION RELEASE:

In order to disseminate as widely as possible timely and significant materials of interest to the educational community, documents announced in the monthly abstract journal of the ERIC system, *Resources in Education* (RIE), are usually made available to users in microfiche, reproduced paper copy, and electronic media, and sold through the ERIC Document Reproduction Service (EDRS). Credit is given to the source of each document, and, if reproduction release is granted, one of the following notices is affixed to the document.

If permission is granted to reproduce and disseminate the identified document, please CHECK ONE of the following three options and sign at the bottom of the page.

The sample sticker shown below will be affixed to all Level 1 documents

PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL HAS BEEN GRANTED BY

Sample

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

1

Level 1 ↑ ☐

Check here for Level 1 release, permitting reproduction and dissemination in microfiche or other ERIC archival media (e.g., electronic) and paper copy

The sample sticker shown below will be affixed to all Level 2A documents

PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL IN MICROFICHE, AND IN ELECTRONIC MEDIA FOR ERIC COLLECTION SUBSCRIBERS ONLY, HAS BEEN GRANTED BY

Sample

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

2A

Level 2A ↑ ☒

Check here for Level 2A release, permitting reproduction and dissemination in microfiche and in electronic media for ERIC archival collection subscribers only

The sample sticker shown below will be affixed to all Level 2B documents

PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL IN MICROFICHE ONLY HAS BEEN GRANTED BY

Sample

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

2B

Level 2B ↑ ☐

Check here for Level 2B release, permitting reproduction and dissemination in microfiche only

Documents will be processed as indicated provided reproduction quality permits.
If permission to reproduce is granted, but no box is checked, documents will be processed at Level 1.

I hereby grant to the Educational Resources Information Center (ERIC) nonexclusive permission to reproduce and disseminate this document as indicated above. Reproduction from the ERIC microfiche or electronic media by persons other than ERIC employees and its system contractors requires permission from the copyright holder. Exception is made for non-profit reproduction by libraries and other service agencies to satisfy information needs of educators in response to discrete inquiries.

Sign here, → please

Signature:	Printed Name/Position/Title: Parin Nolecha administrator	
Organization/Address: 21 De Montfort ST. Leicester, LE1 7GE	Telephone: 0116 - 204 - 4210	FAX: 0116 - 204 - 4262
	E-Mail Address: Parin@niace.org.uk	Date: 13/08/02

(Over)

III. DOCUMENT AVAILABILITY INFORMATION (FROM NON-ERIC SOURCE):

If permission to reproduce is not granted to ERIC, *or*, if you wish ERIC to cite the availability of the document from another source, please provide the following information regarding the availability of the document. (ERIC will not announce a document unless it is publicly available, and a dependable source can be specified. Contributors should also be aware that ERIC selection criteria are significantly more stringent for documents that cannot be made available through EDRS.)

Publisher/Distributor:	NIACE / CENTRAL BOOKS
Address:	NIACE 21 DeMontfort ST. Leicester LE1 7GE Central Books 99 Wallis Road London, E4 5LN
Price:	£8.95

IV. REFERRAL OF ERIC TO COPYRIGHT/REPRODUCTION RIGHTS HOLDER:

If the right to grant this reproduction release is held by someone other than the addressee, please provide the appropriate name and address:

Name:	
Address:	

V. WHERE TO SEND THIS FORM:

Send this form to the following ERIC Clearinghouse:

Acquisitions Coordinator
ERIC Clearinghouse on Adult, Career, and Vocational Education
Center on Education and Training for Employment
1900 Kenny Road
Columbus, OH 43210-1090

However, if solicited by the ERIC Facility, or if making an unsolicited contribution to ERIC, return this form (and the document being contributed) to:

ERIC Processing and Reference Facility
4483-A Forbes Boulevard
Lanham, Maryland 20706

Telephone: 301-552-4200
Toll Free: 800-799-3742
FAX: 301-552-4700
e-mail: ericfac@inet.ed.gov
WWW: http://ericfacility.org